TECHNOLOGY ASSESSMENT & FORECAST

U.S. DEPARTMENT OF COMMERCE

Patent and Trademark Office

TECHNOLOGY ASSESSMENT & FORECAST

TENTH REPORT
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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldridge, Secretary

Gerald J. Mossinghoff
Commissioner of Patents
and Trademarks

William S. Lawson
Director, Office of Technology
Assessment and Forecast

U.S. DEPARTMENT OF COMMERCE
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CONTENTS

INTRODUCTION		1
SECTION I	- ACTIVE TECHNOLOGIES	7
Part I	- Most Active Patent Technologies (Ranked by Actual Growth)	12
Part II	- Actual Growth vs Percent Growth	19
Part III	- Fastest Growing Patent Technologies (Ranked by Percent Growth)	20
Part IV	- Most Foreign-Active Patent Technologies (Ranked by Percent Foreign Share)	27
SECTION II	- PATENT TRENDS Foreign Multinational Corporation Patenting Trends in the U.S.	33
SECTION III	- SOFTWARE RELATED TECHNOLOGIES Patentability: Past To Present	47
Part I	- A Brief History	49
Part II	- Recent Supreme Court Decisions	52
Part III	- Patent Activity Analysis	59
SECTION IV	- AEROSPACE TECHNOLOGY PATENTING A Demonstration of the Use of the Patent File	73
Case I	- A Tool For Historical Review	79
Case II	- A Valuable Research Tool	88
Case III	- A Bibliographic Data Source	91
APPENDICES		99
Appendix A1	- DATA TABLES (SECTION II)	101
Appendix A2	- ADDITIONAL POLICY, LEGAL DECISIONS, AND CITATIONS (SECTION III)	126
Appendix B	- OBTAINING PREVIOUS OTAF PUBLICATIONS	157
Appendix C	- OBTAINING ADDITIONAL INFORMATION OR SPECIAL REPORTS	161
Appendix D	- ACKNOWLEDGEMENTS	175

INTRODUCTION*

Background

The Patent and Trademark Office has assembled one of the largest collections of technological literature in the world -- the classified patent search file, which contains more than 24 million technological documents distributed among 108,000 subdivisions of technology.

Each year about 250,000 new U.S. patent documents are added to this file, along with 240,000 new foreign patents. A sizeable staff is engaged full time in reviewing this file and restructuring it to accommodate new technologies and changes in existing technologies.

In its own unique way, this file represents a national resource. The Patent and Trademark Office recognizes heavy responsibilities not only to preserve, maintain, and improve the file, but to maximize its use for the greatest public benefit, as well. As part of the effort to discharge this latter responsibility, the Patent and Trademark Office established, in 1971, its technology assessment and forecast program.

In its most general terms, the mission of the program is to stimulate and enhance the use and usability of the patent file, and to assemble, analyze and make available meaningful data about the file. In carrying out this mission, the Office of Technology Assessment and Forecast (OTAF), which adminsters the program, has assembled and built a master data base covering all U.S. patents. It periodically updates this base and strives continually to add new data items to it. Recent additions to the base are the addresses of independent inventors and the field of search and references cited in the patentability examination leading to the patent grant. Other items in the data base are patent application date data, and relationships between the Patent Classification system and the Standard Industrial Classification (SIC) system, the latter item permitting broad scale use of patent data in economic studies.

OTAF uses the data base in two principal ways: First, it periodically issues general distribution publications. These publications have included reports on highly active technological areas, areas experiencing high levels of patenting by foreign residents, profiles of the patenting patterns of the residents of selected foreign countries and U.S. states, reviews of the patent activity of the most active patent assignees, and comparisons of patent activity with economic activity in selected Standard Industrial Classification categories. In addition, several of the publications have examined the patenting in high interest energy technologies. A listing of previous OTAF publications and information as to how they may be obtained can be found in Appendix B.

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*The material on this and the following pages substantially duplicates that presented in previous publications. Those familiar with the Office of Technology Assessment and Forecast and the program it adminsters may wish to begin reading on page 4.

The second principal use of the OTAF data base is made in preparation of special reports tailored to individual needs. These reports, which are provided on a cost reimbursable basis, have been utilized by many government agencies and a large number of private sector organizations. More information concerning the OTAF special report service can be found in Appendix C.

Patents And Patent Activity

Over four million United States patents have issued since the first was granted on July 31, 1790. To facilitate the use of this large body of technology, these documents have been "classified" (categorized) into about 370 broad technological groupings (called Classes) and approximately 108,000 specific technological categories (called subclasses). Together, these Classes and subclasses form the structure of the classified patent file.

Copies of a patent are placed in more than one subclass of this file when the patent contains significant technology pertinent to more than one subclass. With such multiple placement or "cross-referencing" the patent file has grown to contain approximately 12,800,000 U.S. patent documents spanning the entire technological spectrum*.

Since a patent obtained in the United States conveys no protection outside this country, and vice versa, it is common in this age of the "international market place" for inventors to obtain patents in more than one country. As a result, significant foreign inventions are usually patented in the United States because it is such an important market. Thus, U.S. patent activity is representative not only of U.S. technological effort, but, to a large extent, of foreign technological effort as well.

For example, the growth of foreign technological capabilities in the 1960's and 1970's has been mirrored by the growth, over the same period, of the share of U.S. patents granted to foreign resident inventors. In 1961, only about 17% of U.S. patents were issued to residents of foreign countries. However, by the end of 1980, the foreign share had increased to about 40%.

This apparent interrelationship between technological and patent activity gave rise to the basic premise of the technology assessment and forecast program -- that patent activity is an indicator of technological activity, both domestic and foreign.

Patent Data - Use, Meaning and Limitations

Patent data represent a comprehensive, in-depth technological activity information resource. The value of patent data is enhanced by the lack of quantitative indicators which comprehend the entire technological spectrum and which are available in time series going back to the very beginnnings of the United States. Patents, perhaps, are the only such indicator. Consequently, the potential uses of patent data are many and intriguing.

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*The file also contains about 10 million patents of other nations and over 1 million pieces of non-patent literature.

It has been only in recent years, however, that these data have begun to be considered for use to any significant extent. This is the case because patent data, on any but a gross or aggregate basis, have simply not been reasonably available to those who might like to use them.* With the advent of OTAF and its computerized data base, this inhibiting barrier to the use of patent statistics has, to a large extent, been eliminated and workers in many fields have been presented with a new tool.

As a new tool, patent data, their limitations, strong points and parameters for appropriate use have not been well established and are themselves the subject of discussion and study. This is necessary and beneficial. It is one of OTAF's goals to advance and facilitate efforts to learn more about the legitimate implications that can be drawn from patent statistics. It is obvious that in the analysis of these statistics, many factors need to be considered. Among these are the variance between patents in importance and degree of invention. Also, the propensity to patent, as opposed to relying on patent alternatives (e.g., lead time in the market place and trade secrets) may vary over time within an industry and between industries. These factors and others may well affect any use of, or conclusions drawn from, patent statistics. The more disaggregated the data, perhaps, the more important each of these factors become.

Yet, like the mountain, patent data are "there" and cannot (and we strongly believe, should not) be ignored. The data are becoming more available, more detailed, and more useable every year. In the final analysis, it cannot be denied that each patent represents, to some degree, a new piece of technology and, inferentially, some increment of technological activity. Together (in the hundreds, thousands and tens-of-thousands), patents reveal the "who, where and what" about substantial amounts of new technology and technological activity. It seems intuitively obvious then, that clear trends in patenting, especially within a given industry or technology, must be capable of telling us something.

It may be, as some allege, that patenting trends are more indicative of the health of the patent system than of the health of technology. Or it may be that the trends reveal more about the shifts in domestic technological development than about the relative balance between domestic and foreign technology. On the other hand, perhaps they can indeed tell us much about where the U.S. stands overall or in any specific technology as compared to all other foreign countries or to any specific foreign country.

Most probably patent data tell us something about all these things, in some mixture yet to be determined. It will require investigation and study to establish to any widely accepted degree the true meanings of trends suggested by the patent data. We are confident, however, that the data's comprehensiveness and availability will stimulate this investigation and study.

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*Jacob Schmookler, in his book, Invention and Economic Growth (Harvard University Press, 1966), notes on page 21 that a year of effort was invested in the Public Search Room of the U.S. Patent Office collecting the data needed for his studies.

In the interim, use of the data by OTAF and others for a wide variety of purposes will continue. For, just as patents offer substantive technological information available nowhere else,* so do patent data offer a unique indicator of worldwide technological activity -- an indicator which, when wisely used, may permit new insight into the complex interactions of technology and the economy.

About the Contents of This Publication

As with previous OTAF publications, this report illustrates the wide variety of uses for patent information. The four widely divergent sections of this report examine patent activity from both a statistical and a substantive standpoint -- exploring patent activity as an indicator of technological activity and as a source of technological information pertinent to a given industry.

Section I -- "Active Technologies" -- examines PTO subclasses that are very active or predominantly of foreign origin as an aid to the identification of technologies having such characteristics. This section, an update of a study published in OTAF's Ninth Report,** presents the fifty most active subclasses in each of three disciplines (Chemical, Electrical, and Mechanical) and in each of three categories (highest growth, highest growth rate, and highest foreign resident inventor share).

In Section II, OTAF examines the influence in the U.S. technology market of ten foreign multinational enterprises -- the five European and the five Japanese corporations owning and/or controlling the most U.S. patents for the period 1969-1980.

Previous reports and publications of OTAF, in their use and analysis of patent data, have attempted to describe foreign technology developments in terms of U.S. patents of foreign origin (i.e, where the residence of the first named inventor is foreign) or foreign filed patent documents available from the Derwent data base.*** While both methods provide useful indications of foreign technological activity, they do not take into account patents of U.S. origin that are controlled by foreign interests. Hence, they do not measure total foreign influence over U.S. patented technology.

U.S. origin patents owned or controlled by foreign interests are those having a U.S. resident inventor and an assignment to a foreign owned or controlled corporation. Examples include the many U.S. origin patents to the U.S. subsidiary of Ciba-Geigy Corporation, a Swiss firm. These foreign controlled U.S. origin patents, taken together with foreign origin U.S. patents, potentially provide a better measure of foreign activity and certainly a better indication of foreign influence in the U.S. patented technology market.

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*See Section II "The Uniqueness of Patents as a Technological Resource", Eighth Report of the Office of Technology Assessment and Forecast (December 1977).

**See Section I "Active Technologies," Ninth Report of the Office of Technology Assessment and Forecast (March 1979), and the November 16, 1979 edition of "Commerce News."

***Derwent Publications, Ltd. of London, England, is a private organization which provides various kinds of information services relating to patents issued throughout the world.

In Section III, a PTO Examiner analyzes patenting in computer software related technologies by (1) tracing the history and anomalies in the development of the law dealing with the patenting of software and algorithm related inventions, (2) discussing the present status of the law in this field, and (3) showing how these developments have apparently affected patenting in the exemplary field of seismic data processing.

The final section of the report, Section IV, examines patenting in Aerospace technology to (1) demonstrate uses of patent information and (2) disseminate substantive information about this technology. The emphasis of this section is clearly on the former, and three uses of patents are presented -- first, as a tool for historical review; second, as a valuable research tool; and third, as a bibliographic data source.

The Report concludes with four appendices. Appendix A contains supportive data for two sections of this report as follows: Appendix A1 contains tables of corporate patenting data relied upon in Section II. Appendix A2 is directed to Section III. It presents citations and notes, and additional policy considerations and legal decisions affecting patenting in software technologies. Appendix B lists and briefly describes previous OTAF publications, and explains how they may be obtained. Appendix C gives information about OTAF's special report services and includes excerpts from samples of two "standard type" special reports. Appendix D names and acknowledges the assistance of the many Patent and Trademark Office personnel who have contributed to this publication.

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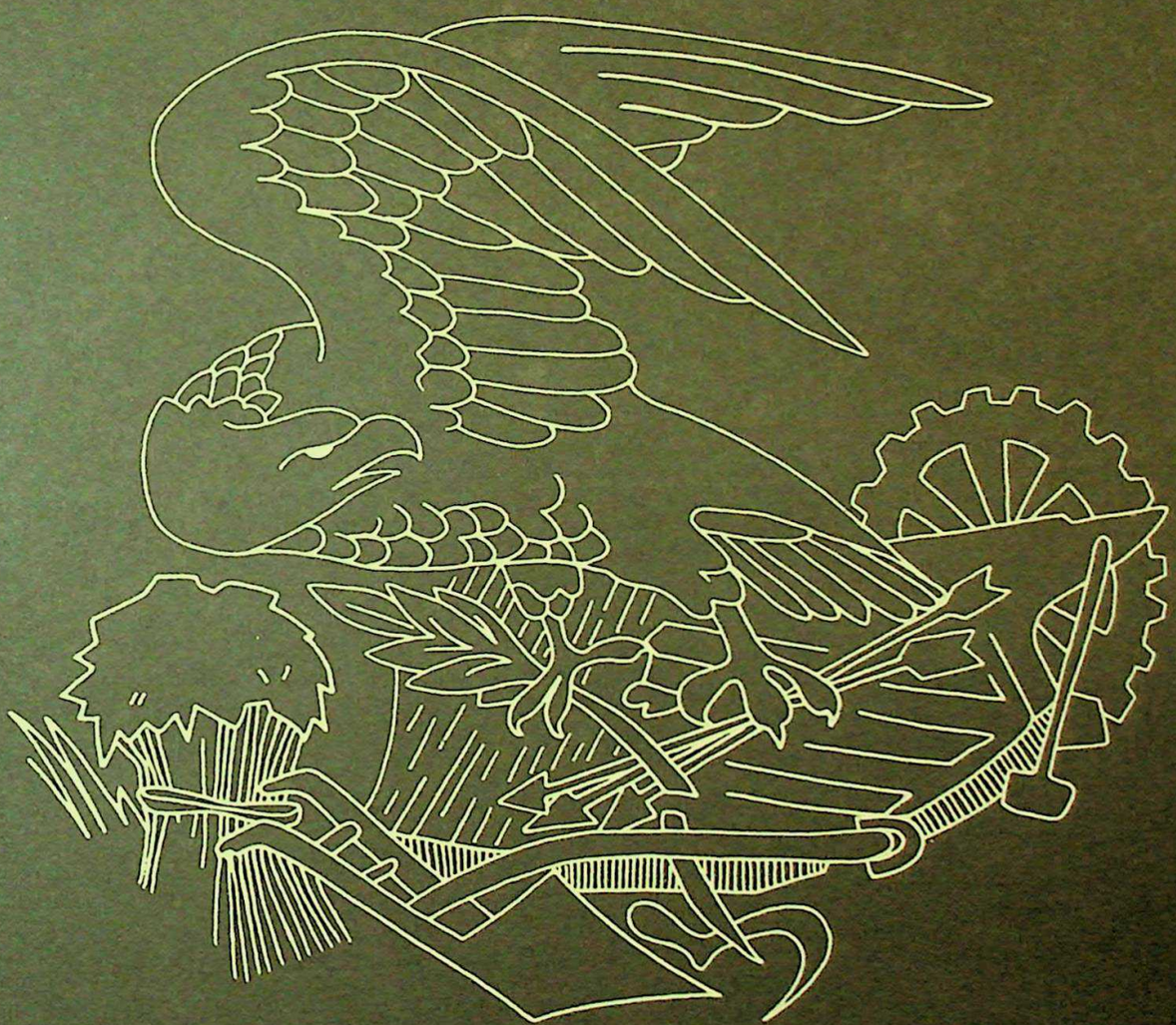
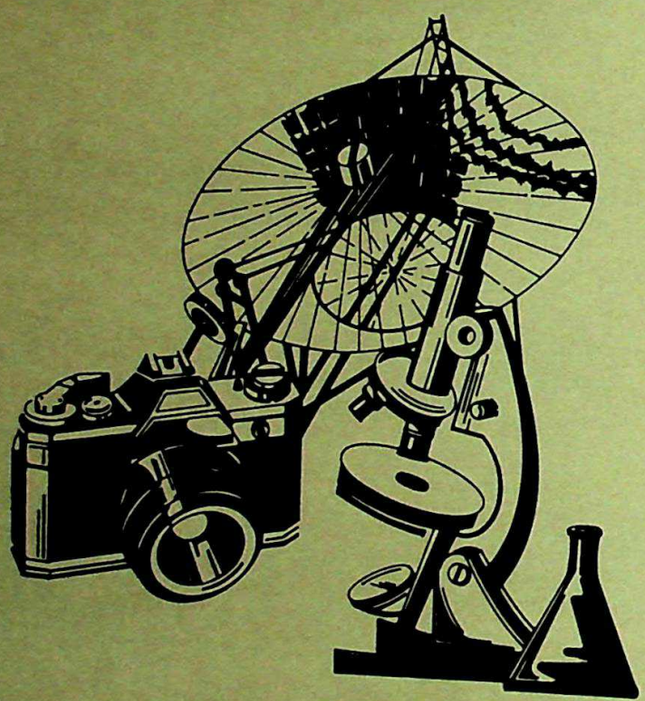


The Patent System added the fuel o
interest to the fire of genius. A Lin

SECTION I - ACTIVE TECHNOLOGIES

Part I	-	Most Active Patent Technologies (Ranked by Actual Growth)	12
Part II	-	Actual Growth vs Percent Growth	19
Part III	-	Fastest Growing Patent Technologies (Ranked by Percent Growth)	20
Part IV	-	Most Foreign-Active Patent Technologies (Ranked by Percent Foreign Share)	27



INTRODUCTION

In this Section, OTAF takes a look at the recently active patent technologies as determined from high-growth areas of the U.S. patent file for the years 1978-1980. These technologies are identified by ranking the top 50 patent subclasses by discipline (Chemical, Electrical, and Mechanical) in each of three categories: MOST ACTIVE TECHNOLOGIES, FASTEST GROWING TECHNOLOGIES, AND MOST FOREIGN-ACTIVE TECHNOLOGIES. The hope is that such an activity review may prove to be a useful index in forecasting technology directions.

This Section begins with a brief outline of the U.S. patent file structure and a discussion of risks inherent in the use of patent data at the subclass level, the most elemental patent technology breakdown. Caveats in place and parameters explained, OTAF then performs a four-part patent activity analysis beginning with an examination of the actual file growth* of the top-ranked subclasses for each of the three major disciplines, Chemical, Electrical, and Mechanical.

Following a detailed illustrative explanation of the difference between actual file growth* and percent (relative) growth*, is a review of the fastest growing patent subclasses.

Finally, noting in the foregoing analyses apparent discernable trends in foreign-origin patenting, the technology areas experiencing the highest foreign activity are probed.

MOST ACTIVE TECHNOLOGIES . . . . . TABLE SERIES A . . . PAGE 13
ranked in terms of actual file growth

FASTEST GROWING TECHNOLOGIES . . . . TABLE SERIES B . . . PAGE 21
ranked in terms of percent growth

MOST FOREIGN ACTIVE TECHNOLOGIES. . TABLE SERIES C . . . PAGE 28
ranked in terms of percent foreign origin

*Terms defined -- page 11.

BACKGROUND

The U.S. Patent File Structure

As noted on page 1 of this report, the U.S. patent file grows each year by an average of about 250,000 U.S. patent documents. To facilitate an investigation or search of the scientific and technical information presented in these documents, now totaling more than 12.8 million U.S. patent copies, a systematic arrangement or subdivision of the subject matter was established. This classification system consists of about 370 general categories or Classes distributed among the three major disciplines: Chemical, Electrical, and Mechanical.*

This classification system has been further refined to include more than 108,000 subdivisions, called subclasses, that are maintained in a logical scheme or schedule within those Classes.

A Research Tool

It is important to reemphasize here that this file -- consisting of these 108,000 subclasses of technology -- is not fixed. It is dynamic, growing and ever-changing to reflect the rapidly changing state of technology.

It is the relative change in this file, measured over time, that OTAF has focused upon in an attempt to define the areas of most significant patenting activity, and thus, perhaps, the directions of technological growth.

Accepting the Risks

As with any analysis of this type, it is necessary that we take the risk of being mislead by the statistics. It is well known among patent file experts that subclasses were never "created equal" in terms of scope or content and, consequently, are often not directly comparable with each other in size and growth. In particular, some subclasses cover a wide range of subject matter within a generic title, while others, parts of more highly defined schedules, are so exclusive in scope that their individual growth appears very small even though they may be components of a highly active, fast-growing technology. For example, a single subclass exhibiting a level of growth not particularly impressive by comparison with the average patent file growth might thus be discounted at the outset. This same subclass, however,

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*Some technologies span more than one discipline and others are not easily categorized. For this study, general type technologies, such as Surgery and Education, are classified in the Mechanical discipline. Optics and Horology (Time Measuring Systems or Devices) are classified in the Electrical discipline. Photography, including cameras, lenses, etc., is also placed in the Electrical discipline, except for purely chemical photographic processes and products. Batteries, including thermoelectric and photoelectric panels and cells, are in the Chemical discipline.

may be only one of a number of well classified, finely divided fractions of a definable whole, the overall (additive) growth of which might indeed be a significant, technology trend indicator.

Hence, caution must be exercised in drawing conclusions based upon the data presented. It is the purpose of this exercise to seek indications of trends rather than absolutes. For such purpose, the patent file offers unique capabilities.

Exercise Parameters

Selected for comparison in each discipline -- Chemical, Electrical and Mechanical -- are the top 50 of the 108,000 subclasses ranked in each of three categories: (1) most active in terms of actual file growth;* (2) most active in terms of percent growth*; (3) most foreign-active in terms of percent foreign-origin.* Subclasses were excluded from the percent growth and foreign origin ranking if they had less than thirty patent documents added during the three-year period examined (1978-1980). This minimum of thirty documents was set to avoid the misleading high percentages resultant in very small subclasses. Each table includes, for comparison purposes, all three measures of activity plus data as to the total (all years) patents in each subclass.**

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*Term definitions:

"Actual Growth" - - - - Numeric increase resulting from additions of patent copies (including cross-reference copies) to the file during the three year period 1978-1980.

"Percent Growth" - - - - A measure of relative growth computed by dividing actual growth for 3-year period examined (1978-1980) by actual growth for 6 year period (1975-1980), and multiplying by 100.

"Percent Foreign Origin" - Foreign inventor share calculated by dividing total U.S. patents to foreign-resident inventors during 1978-1980, by actual growth for the same period, and multiplying by 100.

**Subclasses with alpha designations (e.g.,355/3TR) in many instances originated as "unofficial" divisions of the technology. Due to incomplete inventories, some of the figures in the "Total" column may not accurately reflect the number of patents in these subclasses for years prior to 1975.

PART I -- MOST ACTIVE PATENT TECHNOLOGIES

Extracting the Data

Scanning the approximately 108,000 subclasses to select those which experienced the greatest actual file growth in the three-year period 1978-1980 resulted in the listings displayed in Table Series A, which follows. Ranked by quantitative increase in patent documents (including cross-reference copies) are the "Top 50" for each discipline: Chemical, Electrical, and Mechanical.

TABLE SERIES A

THE MOST ACTIVE TECHNOLOGIES

A-1 CHEMICAL
A-2 ELECTRICAL
A-3 MECHANICAL

TABLE A-1. TOP 50 CHEMICAL SUBCLASSES
(Ranked by Actual Growth)

Cl/Sub	Description	1978-80 Patents	% Growth	% Foreign Share	Total Patents
424/274	Drugs and bioaffecting compositions wherein the active ingredient contains a 5-membered ring having 1 nitrogen atom	639	46.5	46.6	3380
424/267	Drugs and bioaffecting compositions wherein the active ingredient is piperidine or a derivative thereof	562	38.8	51.6	3452
424/250	Drugs and bioaffecting compositions wherein the active ingredient is a compound having a six-membered heterocyclic ring composed of four carbons and two nitrogens	525	38.1	55.8	3075
23/230B	Analytical processes for use in biological systems involving combination of tests or measurements with methods of regulating a reaction	505	53.0	28.7	1593
424/263	Drugs and bioaffecting compositions wherein the active ingredient contains a pyridine not fused to another heterocyclic ring	468	40.4	46.6	2724
424/246	Drugs and bioaffecting compositions wherein the active ingredient contains a 6-membered ring having at least 1 nitrogen and 1 sulfur atom (e.g., cephalosporins)	444	37.4	58.1	2034
424/177	Drugs and bioaffecting compositions containing a proteinaceous material as the active ingredient	441	59.1	41.5	1445
424/180	Drugs and bioaffecting compositions containing a carbohydrate as the active ingredient	397	49.4	48.9	1621
424/273R	Drugs and bioaffecting compositions containing diazole or a derivative thereof as the active ingredient	389	41.4	52.7	2190
260/112.5R	Peptides of known chemical structure and preparations thereof	361	55.3	46.3	1306
148/1.5	Metal treatment process for producing barrier layer stock material	356	49.0	25.8	1617
260/465D	Aromatic nitrile or isonitrile compounds substituted with acid, ester, acid halide, or acid amide groups, and preparations thereof	347	48.7	51.3	1887
424/251	Drugs and bioaffecting compositions wherein the active ingredient contains a pyrimidine ring	343	38.4	55.1	1876
424/12	Drugs and bioaffecting compositions which contain an antibody, a non-living antigen or an antigen-like material useful for testing or diagnosis and intended to be used in vitro	327	61.1	31.2	710
424/270	Drugs and bioaffecting compositions wherein the active ingredient is thiazole or a derivative thereof	306	47.4	46.7	1391
260/40R	Synthetic resins containing a filler, dye or pigment, and formed from the reaction of polycarboxylic acids with polyhydric alcohols	297	48.5	41.8	2311
148/187	Barrier layer stock material production process involving pretreatment of substrate before impurity or localized area diffusing	290	43.9	32.4	1462
424/317	Drugs and bioaffecting compositions containing a carboxylic acid or salt thereof as the active ingredient	289	42.8	45.7	1703
252/408	Compositions for use in physical or chemical analysis, testing or indicating or as warning agents	277	50.8	33.6	1521
428/913	Stock materials or miscellaneous articles designed to be responsive to temperature, light, moisture, etc.	268	59.4	40.7	903
424/285	Drugs and bioaffecting compositions wherein the active ingredient is a compound having a 5-membered heterocyclic ring containing 1 oxygen atom	253	50.0	40.7	1238
560/121	Carboxylic acid esters and processes for their preparation containing a cyclopentyl group in the acid moiety (e.g., prostaglandin esters)	253	44.2	22.5	767
424/330	Drugs and bioaffecting compositions wherein the active ingredient is an aromatic amine (e.g., ephedrine or epinephrines)	251	39.5	47.0	1734
424/258	Drugs and bioaffecting compositions wherein the active ingredient contains a quinoline or isoquinoline ring	247	37.8	53.4	1494
424/275	Drugs and bioaffecting compositions wherein the active ingredient is a compound having a heterocyclic ring containing a sulfur atom	244	46.5	50.8	1154
252/522R	Perfume compositions	243	43.7	42.0	1170
424/324	Drugs and bioaffecting compositions containing an amide of an aromatic acid or of an aromatic amine as the active ingredient	236	49.5	47.0	1352
260/112R	Proteins such as peptides of unknown chemical structure, their reaction products and preparations thereof	233	50.8	46.8	1316
562/503	Cyclopentyl carboxylic acids, such as prostaglandins, and their salts, and preparations thereof	233	45.5	20.6	687
424/1	Drugs and bioaffecting compositions containing a radioactive ingredient	232	60.4	25.0	543
424/244	Drugs and bioaffecting compositions wherein the active ingredient contains a heterocyclic group	230	40.6	47.4	1438
424/304	Drugs and bioaffecting compositions wherein the active ingredient is a nitrile or isonitrile	224	50.3	48.7	961
428/539	Nonstructural laminate of inorganic metal compound	224	56.7	50.9	1256
260/37N	Nitrogen containing synthetic resins to which a filler, dye or pigment has been added	217	45.2	39.2	1489
424/319	Drugs and bioaffecting compositions wherein the active ingredient is an amino acid	217	50.9	51.2	958
148/175	Processes for growing contiguous layers of semiconductive material involving epitaxial depositing of semiconductor material and an impurity	216	43.0	39.4	1199
252/455Z	Zeolite catalysts containing silica or silicate and a Group III metal, metal oxide or hydroxide	208	54.5	14.4	1090
424/272	Drug and bioaffecting compositions wherein the active ingredient is an oxazole	208	49.8	52.9	919
428/447	Nonstructural laminate of siloxane, silicone or silane	205	54.8	33.7	801
252/429B	Ziegler catalyst compositions containing nonmetallic additive	203	65.5	65.0	868
424/305	Drugs and bioaffecting compositions wherein the active ingredient is an alicyclic carboxylic acid ester (e.g., prostaglandin esters)	203	43.7	45.3	677
424/308	Drugs and bioaffecting compositions wherein the active ingredient is an aromatic carboxylic acid ester	201	44.4	57.2	1032
427/54.1	Coating processes involving direct application of ultraviolet light	198	66.9	20.7	395
424/269	Drugs and bioaffecting compositions wherein the active ingredient is a five-membered hetero ring with at least two hetero atoms, one of which is nitrogen (e.g., triazoles)	197	46.2	59.9	664
204/1T	Analysis and testing using electrolysis	196	57.6	44.9	950
428/35	Hollow or container-type stock material (e.g., tube or vase)	191	53.2	27.7	781
536/17R	Oxygen or sulfur glycoside antibiotics	191	58.1	45.0	472
428/914	Transfer or decalcomania material	188	60.5	44.7	743
204/159.23	Catalytic processes using wave energy to produce synthetic resins from unsaturated monomers	186	50.5	36.6	684
542/426	Heterocyclic compounds containing an intercyclic acyclic -CH= chain, a non-carbon atom in the chain and an alicyclic ring (e.g., prostaglandin ethers)	181	62.8	30.4	309

TABLE A-2. TOP 50 ELECTRICAL SUBCLASSES
(Ranked by Actual Growth)

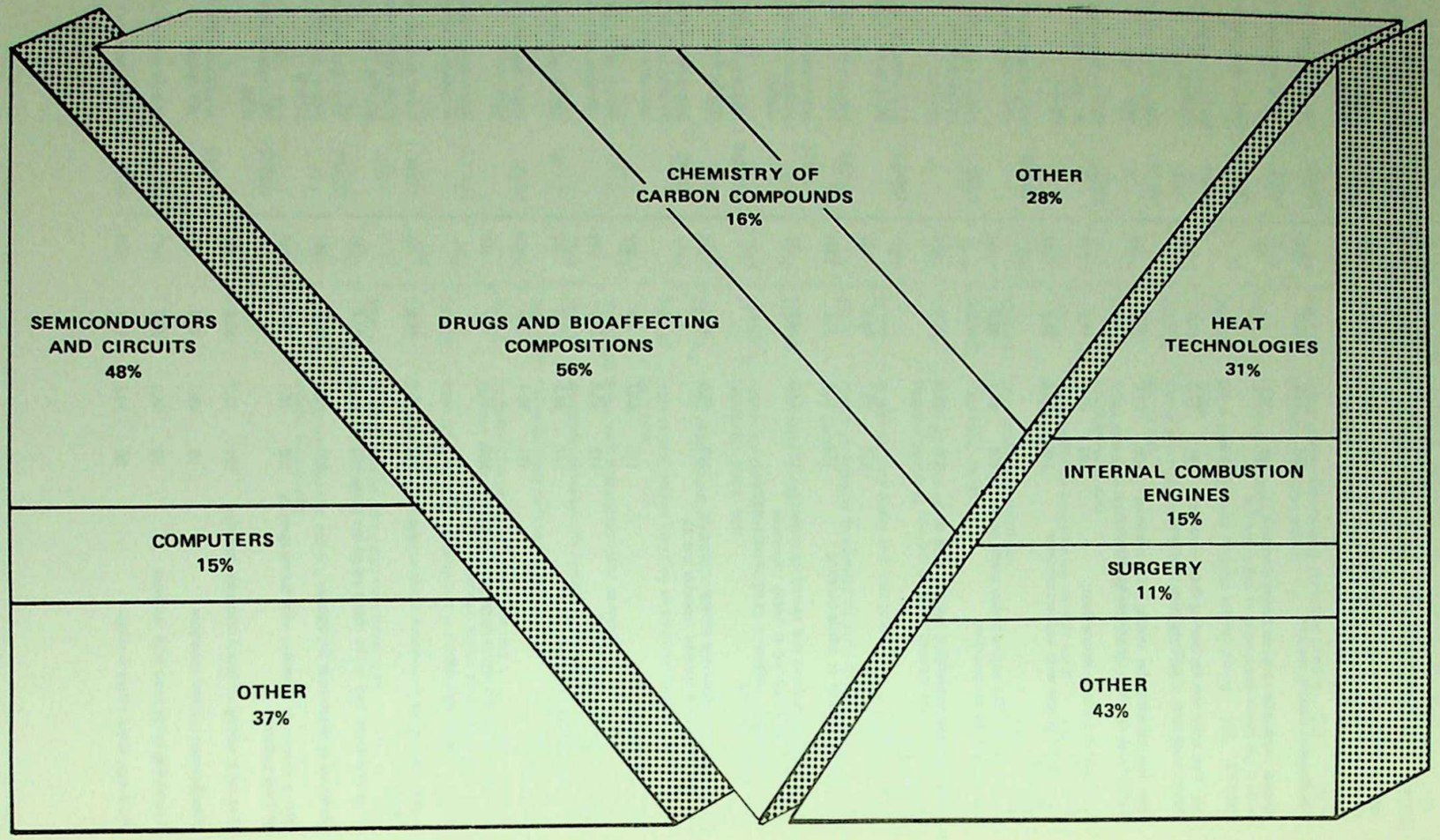
Cl/Sub	Description	1978–80 Patents	% Growth	% Foreign Share	Total Patents
364/200	General purpose programmable digital computer systems	632	51.1	23.6	3022
364/900	Miscellaneous digital data processing systems	548	53.8	24.3	2439
357/23	Active solid state device with insulated gate	338	50.3	35.8	1510
357/30	Light responsive (infrared to u.v.) solid state device	330	53.7	29.7	1511
357/24	Active solid state charge transfer device with insulated gate	254	47.6	33.9	677
357/59	Polycrystalline solid state device	240	59.7	40.4	637
357/91	Ion implant solid state devices	232	54.8	26.7	621
250/445T	Laminography	229	69.0	60.3	404
357/55	Discrete, solid state device with particular external geometry	208	53.3	37.5	1380
307/238	Nonlinear solid state device signal storage circuits	204	48.7	36.8	1034
307/221D	Nonlinear solid state device analog shift registers	199	53.9	31.7	427
84/1.01	Musical instruments having electrical tone generators or translating devices	174	56.5	51.1	865
84/1.24	Electrical musical instruments with device to give expression to the music	173	68.9	47.4	615
357/41	Integrated chip containing field effect transistor	173	52.1	38.7	713
340/347AD	Code converters, encoders with nondiscrete input	159	45.2	26.4	1568
346/75	Recorders using gas blast against receiver	158	49.1	28.5	539
357/68	Active solid state device with ohmic contacts of particular geometry	150	47.3	37.3	1282
350/96.21	Optical fiber connectors having fiber to fiber mating means	141	72.7	46.1	205
357/51	Integrated semiconductor chip combined with passive device (e.g., resistor, capacitor, inductor)	136	53.1	41.2	639
357/15	Active solid state device with metal semiconductor junction (e.g., Schottky barrier)	134	46.9	29.1	656
357/16	Heterojunction transistor	134	47.5	41.0	573
331/94.5G	Gas laser	132	47.0	19.7	444
346/140R	Recorders with ink supply to marker	129	58.1	55.0	730
357/54	Active solid state devices with multiple dielectrics	126	47.9	34.9	626
355/3R	Electric photography	125	29.3	43.2	1101
219/216	Electrical heater for printing or reproduction device	123	44.2	60.2	551
84/1.03	Automatic production of tones in electrical musical instruments	122	62.6	45.9	371
355/77	Photocopying methods using projection printing and copying camera methods	118	70.2	39.8	572
324/51	Electrical fault testing	115	46.4	22.6	1148
357/81	Active solid state device housings having cooling means	115	49.1	35.7	1180
250/227	Optical or pre-photocell system with light conducting rod	113	41.7	32.7	957
357/17	Active solid state device with light emitting junction (infrared to u.v.)	113	41.1	46.9	638
357/71	Active solid state device having multiple layer ohmic contacts	112	43.2	42.0	863
331/94.5C	Laser resonator configuration	110	44.0	20.0	698
350/96.2	Fiber optic connectors	109	73.6	34.9	187
357/22	Active solid state device with junction field effect (unipolar transistor)	109	57.7	42.2	659
357/89	Active solid state device with step junctions	107	50.0	42.1	887
355/8	Electric photography (photocopying) with optical copy scanning	106	46.9	64.2	442
235/92R	Electrically operated registers	105	32.7	34.3	3246
357/52	Active solid state device with surface effects (passivation, guard rings)	104	40.0	34.6	1169
307/304	Field effect transistor circuits	103	29.2	40.8	1007
350/357	Light control systems including an electrochromic light valve	103	69.1	56.3	192
179/100.3V	Spiral track type photographic recorders	102	43.6	63.7	336
354/25	Automatic, photo-electric camera focus control	102	62.6	77.5	226
340/347DD	Digital to digital code converters	100	42.9	36.0	1158
357/46	Integrated chip with plural devices sharing a common active region (e.g., Darlington type)	99	51.8	47.5	486
307/279	Field effect transistor or integrated multivibrators	98	39.5	40.8	592
357/92	Integrated injection logic	98	72.6	52.0	145
360/77	Magnetic recorder with automatic centering of head with respect to the record track	98	68.5	54.1	207
355/14R	Automatic sequential copying and control for electric photography	97	56.4	44.3	382

TABLE A-3. TOP 50 MECHANICAL SUBCLASSES
(Ranked by Actual Growth)

Cl/Sub	Description	1978-80 Patents	% Growth	% Foreign Share	Total Patents
123/568	Internal combustion engine charge-forming device where exhaust gas is mixed with combustible mixture (e.g., emission control valve)	211	58.9	75.8	731
237/1R	Miscellaneous heating systems	181	63.5	18.2	689
123/440	Internal combustion engines having electronic exhaust gas responsive control of carburetor fuel metering	175	79.2	74.3	236
126/450	Solar heat collectors for heating fluids circulated therethrough with specific housing structure	174	77.3	17.8	258
126/438	Solar heat collectors for heating fluids circulated therethrough having a concentrating reflector	170	68.8	19.4	343
60/641	Power plants utilizing natural heat	155	53.3	11.6	409
126/400	Stoves and furnaces with heat accumulator structures	149	66.8	24.8	368
60/276	Internal combustion engine having means to analyze exhaust gas composition	139	67.1	82.0	266
165/105	Condensing and evaporating systems using an intermediate fluent material receiving and discharging heat	138	43.5	31.9	985
400/124	Dot-type matrix printer	138	50.7	48.6	407
414/786	Processes of material or article handling	137	42.4	32.1	1381
282/27.5	Manifolding instruments and operations involving impressible mark forming or facing cooperable coated leaves (e.g., carbonless or no smudge manifold transfer system)	134	63.2	44.0	365
165/104S	Heat exchange and storage apparatus using an intermediate fluent material receiving and discharging heat	118	69.0	34.7	244
126/121	Hot air fireplaces	113	67.7	7.1	472
131/17R	Tobacco product compositions	112	43.8	25.0	673
165/1	Processes of heat exchange	104	54.5	27.9	726
73/23	Gas analysis	103	55.1	35.9	632
123/489	Internal combustion engine having fuel injection actuated by electronic circuit responsive to condition of the exhaust gas	103	71.5	76.7	152
128/214R	Dosing devices for intravenous administration of medicine	103	45.0	14.6	765
128/92C	Bone prosthesis used in the treatment of fractures	102	41.8	41.2	345
128/260	Medicinal applicators or depositors	102	36.6	20.6	761
299/2	Mining process or apparatus with tunnel recovery of fluid material	102	76.1	5.9	223
128/660	Diagnostic testing to detect ultrasonic radiation	101	73.7	36.6	189
128/1R	Miscellaneous surgical apparatus	98	49.7	23.5	658
29/526R	Assembling metal parts with fasteners	90	48.1	33.3	1456
308/9	Fluid-supported rotary bearings	90	50.8	56.7	1036
166/274	Double fluid injection techniques for well processes	89	48.6	6.7	565
285/423	Non-metallic pipe joint or coupling materials	86	48.3	24.4	886
30/276	Cutting tools with rotary blade moving means	84	77.1	16.7	411
128/348	Surgical-type cannula instruments	84	51.2	20.2	451
29/407	Mechanical manufacturing with testing and/or indicating	83	56.8	22.9	860
165/76	Heat exchange apparatus with repair or assembly feature	83	62.9	27.7	586
303/6C	Fluid pressure brakes where fluid is distributed to multiple motors which modify front and rear pressure	83	51.2	83.1	525
166/273	Well processes using injection and producing wells where three or more fluids are injected	82	53.9	6.1	479
60/285	Internal combustion engine having fuel, air or ignition controlled by exhaust gas reactor condition	81	60.4	88.9	190
126/425	Solar heat collector with tracking device controlled by timer or sun position	81	68.6	13.6	146
187/29R	Elevators with electric control mechanism	81	54.0	51.9	1183
112/158E	Sewing machines with zig-zag stitch forming mechanism having vibrating needle and electric control	80	83.3	47.5	106
123/198F	Internal combustion engines with individual cylinder disabling device	80	74.8	41.2	202
126/449	Solar collectors for heating a fluid circulated therethrough with absorbers having extended heat exchange surfaces	80	76.2	13.7	122
29/235	Metal working apparatus for assembling or disassembling resilient articles	79	49.7	27.8	961
220/306	Metallic receptacle with detent retained closure	79	45.7	20.3	827
60/484	Power plants with pressure fluid source and plural motors	78	46.4	25.6	404
56/12.7	Motorized harvester including cutter resiliently or pivotally mounted on its drive means	77	78.6	13.0	214
60/398	Power plants with pressure fluid source and motor utilizing natural energy or having a geographical feature	77	68.7	40.3	242
126/448	Solar collectors where working fluid is conveyed through tubes with laterally spaced fluid conduit sections	77	76.2	20.8	121
166/272	Well processes involving the injection of heated fluids	77	48.7	26.0	465
141/392	Miscellaneous fluent material filling apparatus with receiver	76	56.3	26.3	321
3/1	Miscellaneous artificial body members	75	33.5	18.7	538
47/58	Miscellaneous plant husbandry processes	75	46.6	20.0	1049

FIGURE 1 – 1
TECHNOLOGY DISTRIBUTION
OF
THE TOP 50 U.S. PATENT SUBCLASSES
IN EACH EXAMINING DISCIPLINE
RANKED BY ACTUAL FILE GROWTH

TOP 50 CHEMICAL SUBCLASSES
RECEIVED 14,340 PATENTS



TOP 50 ELECTRICAL SUBCLASSES
RECEIVED 8139 PATENTS

TOP 50 MECHANICAL SUBCLASSES
RECEIVED 5269 PATENTS

Fig. 1-1, on the previous page, is a graphical representation of information extracted from the three preceding tables. In each of the disciplines, Chemical, Electrical, and Mechanical, the listed (most active) subclasses were grouped, where possible, by generic technology e.g., carbon compounds, and the remaining were grouped in an "all other" category. Of the total patent file growth attributed to all 50 listed subclasses in each discipline, that proportion for which a particular technology was responsible is shown. Note that in the three year period, all subclasses of the U.S. patent file grew by 666,226 U.S. patent documents (including cross-references). The 150 ranked subclasses (50 in each discipline) are only one tenth of one percent of all the patent file subclasses, yet they accounted for 27,748 patent document additions or 4.2% of the three year growth.

Each of the groups reveals a number of interesting patterns.

Chemical Subclasses

Patent documents added to the top 50 chemical subclasses during 1978-80 amounted to 14,340 (Table A-1). As in previous years,* this list is once again dominated by two major categories. Twenty-five subclasses involving the broad area of Drugs, Bioaffecting and Body Treating Compositions (Class 424) account for 56% of the added patents. Another nine subclasses directed to the chemistry of carbon compounds (Organic Chemistry-Class 260, and the Class 530-570 Series**) represent 16% of the patents in the active chemical subclasses.

Illustrative of the different degrees of activity in the three disciplines is the comparison of the Chemical, Electrical, and Mechanical tables. The top 50 chemical subclasses added more patents to the file during the three year period than the top 50 mechanical and electrical subclasses combined, accounting for 52% of the added patents as compared to 29% and 19% for electrical and mechanical subclasses, respectively. In fact, each of 36 highest listed chemical subclasses grew by an amount greater than the top-listed mechanical subclass. The apparent higher growth of chemical technology is partly the result of the greater propensity to patent new technology developments in the chemical industry. It is also due in part to greater scope of many chemical subclasses.

Electrical Subclasses

As in previous years, General Purpose Programmable Digital Computer

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*Previous studies of "Active Technologies" which examined the "Top 50" subclasses in each discipline appeared in OTAF's Ninth Report and in the November 16, 1979 edition of "Commerce News."

**The Class 530-570 Series - Organic Compounds and also the Class 520 Series - Synthetic Resins, are integral parts of Class 260, which encompasses the chemistry of carbon compounds. The subject matter of the 520 and 530-570 Series, originally included in Class 260, per se, was reclassified under new class designations for technical reasons, not the least of which was the large volume of patents and divisions of technology in Class 260.

Systems is the most active of all electrical subclasses, receiving 632 additional patent documents during 1978-1980 (Table A-2). Miscellaneous Digital Data Processing Systems turns up in second place with 548 additions. These two subclass areas in Class 364 are so active as to account for nearly 15% of the total patent documents (8,139) added to all of the top 50 electrical categories. Such a high relative level of subclass activity again raises the obvious question of subclass "scope." Twenty-four subclasses from Classes 357 and 307, which relate to semiconductors and circuits, account for 48% of the total patent documents added to all top 50 electrical subclasses, indicating considerable activity in solid state technologies.

Mechanical Subclasses

The most active mechanical subclass during 1978-1980 with 211 patents is Class 123, subclass 568, dealing with internal combustion engines (Table A-3). As a whole, Class 123 accounted for 569 of the 5,269 patents added to the top 50 mechanical subclass listing. Two subclasses of Class 60, also related to internal combustion engines, added 220 patents to the list. In all, internal combustion engine patenting accounted for nearly 15% of the patents. It is significant to note the high corresponding figures exhibited by these subclasses in both the percent growth* and percent foreign columns, suggesting a fast-growing technology seemingly dominated by foreign inventors.

As a class, Stoves and Furnaces, Class 126, adds the largest number of patents to the mechanical listing, with 844 patents under seven subclasses. Five of these subclasses, directed to solar heat collectors, together with the related subclass in Class 60, directed to the use of natural heat in power plants, account for 14% of the patents -- an indication of the strong interest in new and alternative energy sources. It is interesting to see that the activity in these energy-related technological areas appears to be principally domestic, as the corresponding foreign share percentages of 11.6 to 17.8% are low in comparison with an all technology foreign share of 38.5% for the same three-year period. Class 165, directed to heat exchange processes and apparatus, appears four times in Table A-3, with a total of 443 patents, and Class 237, subclass 1R, Miscellaneous Heating Systems, is second on the list with 181 patents. In total, heating-related technologies account for 31% of the patents.

Class 128, Surgery, also appears frequently in table A-3, adding 587 patents, 11% of the total, in subclasses ranging in scope from intravenous dosing devices to medicinal applicators and miscellaneous surgical apparatus.

* * *

Included in the foregoing tables is the "percent growth" for that particular technological category. This information provides another perspective for analysis.

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* In subsequent parts of this Section, the significance of "Percent Growth" factors will be explained.

PART II -- ACTUAL GROWTH VS. PERCENT GROWTH

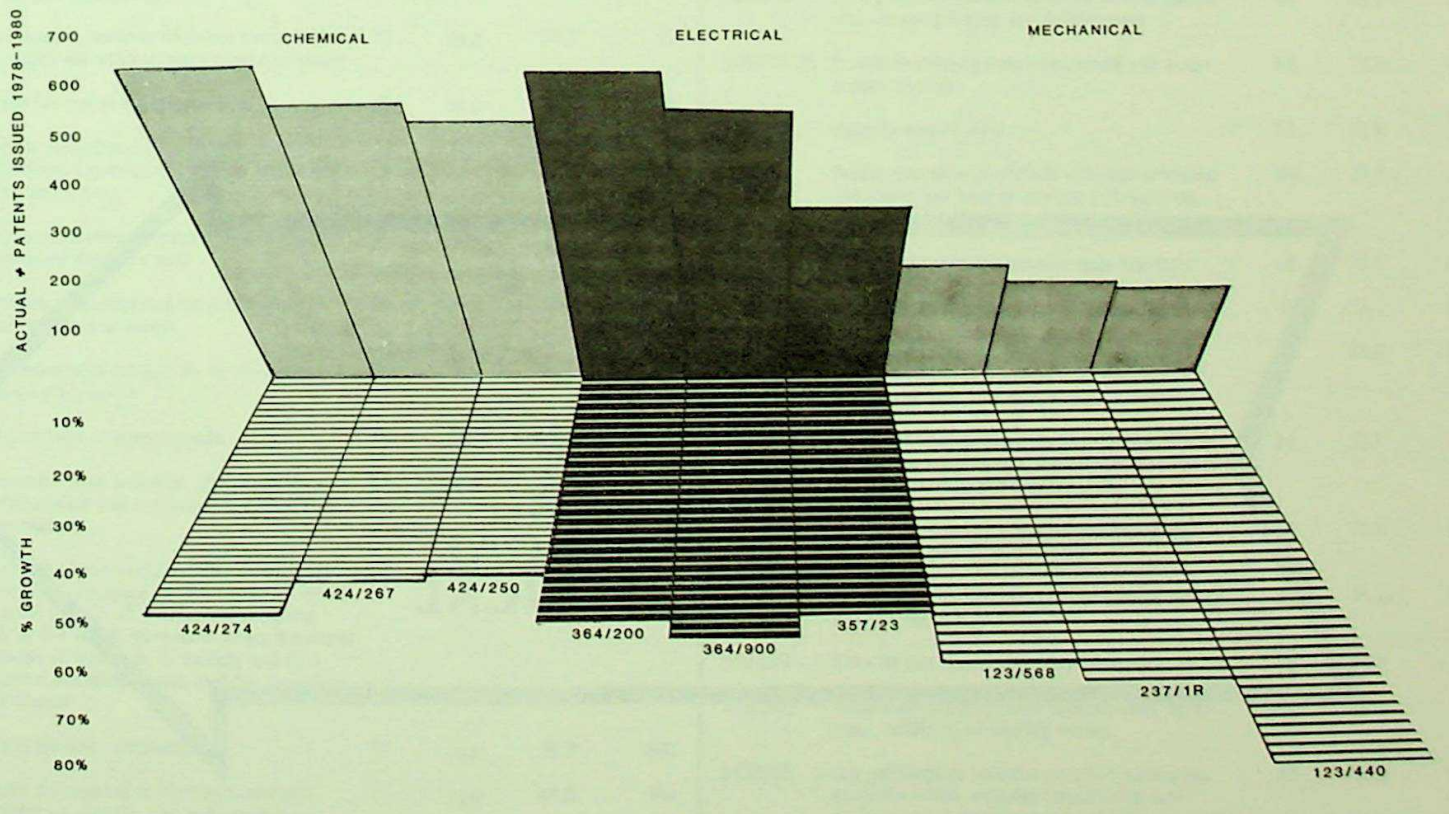
In the immediately preceding pages, an analysis was made of most active patent subclasses ranked in terms of actual file growth. Since each patent represents a direct result of activity in at least one technical field, much can be said for the value of raw numbers in technological measurement and comparison analyses. However, raw numbers do not tell the full story in the search for meaningful patterns and trends.

Another method of measuring file expansion is by percent growth over time. As noted before, OTAF computes this figure for a subclass by dividing the actual growth for the three-year period 1978-1980 by the growth of that subclass over a six-year period 1975-1980 (multiplied by 100 to give a % rate). For example, a new subclass which experienced all of its growth during 1978-1980 would show a growth figure of 100%. Thus, a high value indicates recent activity.

FIGURE 1 - 2

ACTUAL GROWTH vs PERCENT GROWTH

TOP THREE U.S. PATENT SUBCLASSES IN EACH DISCIPLINE
(RANKED BY ACTUAL GROWTH)



The two methods of file expansion measurement -- raw growth and percent growth -- yield different results. For example, Fig. 1-2 shows for each discipline (Chemical, Electrical, and Mechanical) the top three subclasses ranked by actual growth (1978-1980). On the lower portion of this "shadowgram," the percent growth for each of the ranked subclasses is shown along a percentage scale. Since the average percent growth for all technologies for that time span is around 46%, those of the top-ranked subclasses experiencing significantly more percent growth than average are more likely to be the "emerging technologies." Note that the top three chemical and electrical subclasses, which were well above the top three mechanical in terms of actual growth, were substantially below the mechanical subclasses in terms of percent growth. Only the mechanical subclasses show percent growth rates which are substantially above average. Mechanical Class 123, subclass 440, which ranks far below the top chemical and electrical classes in actual growth displays a growth rate of 79.2% -- dramatic when compared to the 46.5% rate for the highest-ranked actual growth entry, chemical Class 424, subclass 274.

* * *

What follows is an analysis of the most active U.S. patent subclasses in terms of percent growth rather than actual growth, highlighting those subclasses having high growth activity relative to subclass size over the three year period 1978-1980.

PART III -- FASTEST GROWING PATENT TECHNOLOGIES

Assessing the U.S. patent file again for a ranking of the active subclasses, OTAF selected (from all 108,000) the top 50 in terms of percent growth, again for each of the three examining disciplines. The results are displayed in Table Series B.

TABLE SERIES B

THE FASTEST GROWING

TECHNOLOGIES

B-1 CHEMICAL
B-2 ELECTRICAL
B-3 MECHANICAL

TABLE B-1. TOP 50 CHEMICAL SUBCLASSES
(Ranked by Percent Growth)

Cl/Sub	Description	1978-80 Patents	% Growth	% Foreign Share	Total Patents
201/41	Miscellaneous thermolytic distillation processes	38	88.4	68.4	83
525/398	Synthetic resins from a mixture containing a solid polymer derived from an aldehyde or derivative as sole reactant with no more than one methylol group	31	83.8	45.2	117
528/111	Synthetic resins from a 1,2-epoxy-containing reactant; a phenol, phenol ether or inorganic phenolate; and a nitrogen-containing alcohol, or ether	34	82.9	26.5	117
260/449.6M	Hydrogenation of carbon oxides using an iron, cobalt, or nickel catalyst	60	82.2	18.3	77
156/DIG 64	Adhesive bonding or miscellaneous chemical manufacture involving silicon or silicon compounds	32	82.1	43.8	46
568/330	Ketones containing a benzene ring and a five-membered alicyclic ring	72	81.8	15.3	147
429/111	Deferred action type batteries where electric current is produced by light responsive chemical reaction	47	81.0	12.8	95
23/915	Immunoassay processes	34	81.0	41.2	99
528/494	Treating of solid polymer or intermediate with an ether	36	80.0	38.9	217
203/DIG 1	Distillation process using a solar still	39	79.6	10.3	126
423/DIG 16	Inorganic chemistry processes involving suspension of finely divided material in a stream of gas (e.g., fluidization)	39	79.6	38.5	67
210/508	Fibrous filter material which is coated or impregnated (e.g., adhesively bound)	31	79.5	48.4	203
427/393.6	Heating or drying an asbestos, ceramic, concrete or masonry base which has been coated with an organic resin, resin precursor, rubber or hardenable oil-containing coating	37	78.7	45.9	134
427/443.1	Immersion coating wherein chemical compound reducing agents are utilized; electroless deposition	33	78.6	24.2	99
204/295	Diaphragms for use in electrolytic cells	43	78.2	25.6	202
423/228	Modifying or removing carbon dioxide or hydrogen sulfide from a gaseous mixture by treatment with an organic amine	46	78.0	17.4	126
201/12	Thermolytic distillation processes using preheated inert, particulate disparate solid	40	76.9	12.5	150
136/258	Polycrystalline or amorphous semiconductor photoelectric panels or arrays	75	76.5	18.7	118
260/45.7PH	Synthetic resins with mono-, di- or tri-phosphate or phosphite preservative	68	76.4	44.1	93
424/48	Chewing gum type pharmaceuticals	55	76.4	30.9	155
528/168	Synthetic resins from a phenol, phenol ether or inorganic phenolate and a nitrogen and phosphorus containing reactant	55	76.4	14.5	147
526/125	Polymerization of only ethylenically unsaturated monomers in the presence of 1) a transition metal or compound thereof, 2) a halogen-containing Group IA or IIA metal compound where the metal is not bonded to hydrogen or carbon, and 3) a non-transition elemental metal, hydride or carbon derivative thereof	97	76.4	75.3	249
75/251	Loose metal particle compositions	38	76.0	28.9	281
542/430	Heterocyclic compounds containing intercyclic acyclic -CH=, an alicyclic ring and plural hetero rings	41	75.9	41.5	149
252/108	Soap-containing detergents	78	75.7	28.2	250
136/251	Encapsulated photoelectric panels or arrays	31	75.6	12.9	60
156/643	Etching substrates by high energy radiation or plasma	123	75.5	26.8	254
252/174.11	Perfume-containing detergent compositions	98	75.4	28.6	151
252/411S	Processes for regeneration or reactivation of sulfur-poisoned catalysts	30	75.0	26.7	92
528/171	Synthetic resins from a phenol, phenol ether or inorganic phenolate and reactant containing sulfur directly bonded to oxygen	33	75.0	42.4	168
544/346	Compounds having tricyclo ring system with 1,4-diazine as one of the cyclos, three or more hetero atoms and ring nitrogen shared by two of the cyclos, e.g., ergot and alkaloids	30	75.0	53.3	85
208/10	Preparation of mineral oils by catalytic hydrogenation of solid natural source material	103	74.6	9.7	342
536/115	Esters of carbohydrate compounds, and preparations thereof	34	73.9	55.9	76
156/653	Sequentially etching the same surface of a silicon containing substrate, each etching exposing a surface of an adjacent layer	45	73.8	17.8	85
528/399	Synthetic resins prepared from a nitrogen containing phosphorus compound	50	73.5	18.0	172
136/248	Photoelectric panel with concentrator, orientator, reflector, or cooling device and hybrid conversion system	41	73.2	12.2	60
542/429	Heterocyclic compounds containing an intercyclic acyclic chain containing -CH= and an alicyclic ring	155	73.1	34.2	346
430/353	Thermographic processes where heat is applied after imaging during dry development	46	73.0	39.1	161
260/326.26	Polymide poly-pyrrole compounds and preparation thereof	43	72.9	55.8	120
202/234	Directly heated stills	51	72.9	19.6	371
427/270	Production of non-uniform coatings involving deforming the base or coating and applying superimposed diverse coatings	40	72.7	25.0	217
429/27	Battery containing electrode-type fuel cell	48	72.7	68.7	194
106/38.9	Inorganic mold and mold coating compositions	45	72.6	22.2	368
536/53	Carbohydrate compounds containing oxygen double bonded and nitrogen bonded directly to same carbon, and preparation thereof	39	72.2	64.1	140
264/29.5	Processes of carbonizing to form non-metallic articles with addition of carbonizable material to carbon article and recarbonizing	31	72.1	29.0	104
156/605	Method of forming single crystal including adding or removal of a dopant	33	71.7	63.6	143
560/89	Esters of aromatic polycarboxylic acids having polyoxy alcohol moiety	33	71.7	30.3	247
568/367	Ketones containing more than one alicyclic ring	38	71.7	21.1	125
136/246	Photoelectric panels with concentrator, orientator, reflector, or cooling device	101	71.6	14.9	195
210/673	Ion exchange or selective sorption separation processes which includes regenerating ion-exchange or sorbent material utilizing gas, water or chemical oxidizing or reducing agent	42	71.2	45.2	210

TABLE B-2. TOP 50 ELECTRICAL SUBCLASSES
(Ranked by Percent Growth)

Cl/Sub	Description	1978–80 Patents	% Growth	% Foreign Share	Total Patents
313/422	Flat cathode ray tube with beam deflecting device	40	87.0	12.5	120
350/349	Electrical excitation means for liquid crystal systems having variable absorption of light due to an additive in the liquid crystal material	30	85.7	20.0	43
360/74.1	Magnetic tape recorders with automatic stopping or reversing of recorder mechanism	33	84.6	66.7	62
362/806	Ornamental or decorative illumination devices	33	82.5	21.2	272
273/85G	Electronic, simulated games	31	81.6	9.7	46
362/431	Pole- or post-type illumination supports	44	81.5	9.1	287
363/96	Electric current inverters with separate, cooperating sensing and control means including thyristor control in the line circuit	42	80.8	52.4	112
343/700MS	Microstrip radio wave antennas	53	80.3	5.7	75
333/246	Wave transmission lines and networks including strip-type long line elements and components	47	79.7	31.9	134
363/97	Electric current inverters with separate, cooperating sensing and control means including transistor control in the line circuit	47	79.7	40.4	107
362/346	Illumination using separate plural reflector systems	39	79.6	33.3	377
354/106	Exposure identification cameras	30	78.9	93.3	143
375/2	Pulse or digital communications systems with unauthorized use prevention	43	78.2	23.3	99
364/515	Computer image processing	81	77.9	28.4	118
343/715	Rod-type radio wave antenna supported by vehicle body	66	77.6	9.1	161
274/15R	Record turntables with automatic tone arm return	37	77.1	83.8	452
354/289	Camera setting indicators	94	76.4	95.7	227
368/85	Chronological time measuring devices with pulse transforming means	32	76.2	84.4	59
354/62	Eye, mouth or body photography	41	75.9	70.7	150
350/96.23	Optical fiber transmission cables	69	75.8	59.4	123
364/414	Computer applications for radiation detection or treatment	52	75.4	50.0	78
358/22	Color television special effects circuitry	42	75.0	52.4	81
200/153G	Electrical circuit makers and breakers which include a toggle lever	38	74.5	26.3	281
273/DIG 28	Amusement devices which employ cathode ray tube	61	74.4	14.8	101
179/1PC	Plugs and connectors for telephone systems	31	73.8	12.9	120
364/472	Computer applications for continuous metal manufacturing	31	73.8	54.8	135
350/96.2	Fiber optics connectors	109	73.6	34.9	187
368/187	Time measuring devices with electrical rate regulation	39	73.6	87.2	141
340/506	Alarm system supervision devices with particular system function	33	73.3	36.4	155
350/96.21	Optical fiber connectors having fiber to fiber mating means	141	72.7	46.1	205
364/705	Digital computers combined with diverse (i.e., non-computing) device	61	72.6	63.9	91
357/92	Integrated injection logic	98	72.6	52.0	143
361/386	Electronic system or device housings or mountings which have thermal conduction cooling means	34	72.3	23.5	144
362/311	Translucent or transparent modifier for light source	39	72.2	33.3	55
365/189	Read/write circuits for static information storage and retrieval systems	65	72.2	32.3	384
290/44	Electric control of windmills	44	72.1	13.6	19
364/521	Computer applications to control data presentation of a cathode ray tube	51	71.8	23.5	121
354/195	Camera focusing	63	71.6	52.4	37
368/10	Time measuring systems combined with other devices	43	70.5	67.4	21
274/47	Sound recording and reproducing using record cleaning devices	31	70.5	54.8	25
355/77	Projection printing and copying camera methods	118	70.2	39.8	57
361/283	Variable electrostatic capacitors which are pressure responsive	35	70.0	22.9	17
340/747	Graphical cathode-ray tube display systems with data responsive intensity generator	37	69.8	24.3	11
354/60F	Camera with photoelectric light responsive device and flash	30	69.8	70.0	
350/96.33	Fiber optics waveguide with multiple core or chadding	32	69.6	46.9	
358/138	Bandwidth reduction of television signal using sampling	32	69.6	53.1	1
358/128.5	Recording and reproducing television utilizing a disc	59	69.4	42.4	
350/357	Light control systems including an electrochromic light valve with optical parameter changed by an applied electrical or magnetic field	103	69.1	56.3	1
333/194	Wave transmission line coupling networks which have an electromechanical filter using surface acoustic waves and include spurious signal prevention or reduction means	38	69.1	55.3	
250/445T	Laminography	229	69.0	60.3	

TABLE B-3. TOP 50 MECHANICAL SUBCLASSES
(Ranked by Percent Growth)

Cl/Sub	Description	1978–80 Patents	% Growth	% Foreign Share	Total Patents
405/303	Miscellaneous hydraulic and earth engineering devices and systems	34	91.9	50.0	53
181/272	Sound mufflers with baffle structure and plural expansion chambers	39	90.7	43.6	81
126/417	Solar heat collectors	39	86.7	12.8	86
277/12	Seals in combination with other significant structure	39	84.8	41.0	337
277/152	Seals having radial inward bias acting on a lip extending axially of the seat engaging part of the seal	44	84.6	36.4	210
112/158E	Sewing machines with zig-zag stitch forming mechanism having vibrating needle and electric control	80	83.3	47.5	106
165/DIG2	Heat exchange apparatus with heat savers	65	81.2	4.6	113
84/293	Neck structure for stringed musical instruments	30	81.1	13.3	180
126/164	Fireplace grates	34	81.0	0.0	219
266/44	Processes of operating metallurgical apparatus	34	81.0	50.0	87
165/174	Heat exchange apparatus using adjacent tubular sections which have internal flow director	51	79.7	37.3	493
181/156	Acoustic diaphragms and enclosures having a reflex baffle	51	79.5	22.9	101
123/440	Internal combustion engines having electronic exhaust gas responsive control of carburetor fuel metering	175	79.2	74.3	236
126/444	Solar collectors where fluid to be heated is conveyed through tubes formed of spaced parallel sheets	57	79.2	10.5	93
56/12.7	Motorized harvester including cutter resiliently or pivotally mounted on its drive means	77	78.6	13.0	214
237/55	Air heating system in which the air is heated by burning a fuel	39	78.0	7.7	164
128/774	Medical diagnostic testing for measuring anatomical characteristic or force applied to or exerted by the body	31	77.5	29.0	82
131/140R	Process for tobacco treatment with fluids or fluent material	31	77.5	41.9	395
126/450	Solar collectors for heating fluids circulated therethrough with specific housing feature	174	77.3	17.8	258
126/447	Solar collectors where fluid to be heated is conveyed through plural tubes connected to common heat absorber plate	54	77.1	35.2	81
110/263	Furnaces utilizing powdered fuel	37	77.1	27.0	191
30/276	Cutting tools with rotary blade moving means	84	77.1	16.7	411
122/20B	Furnaces with subsidiary water heater in off-take flue	30	76.9	13.3	278
277/DIG6	Seals and joint packing materials	36	76.6	33.3	119
126/448	Solar collectors where working fluid is conveyed through tubes with laterally spaced fluid conduit sections	77	76.2	20.8	121
126/449	Solar collectors for heating fluids circulated therethrough with absorbers having extended heat exchange surface	80	76.2	13.7	122
299/2	Mining process or apparatus for recovering fluid material from the earth using horizontal tunnels	102	76.1	5.9	223
56/13.6	Motorized harvesters having separately acting cutter units	34	75.6	73.5	233
425/462	Plastic article or earthenware shaping apparatus having a shaping orifice employing plural distinct feed inlets	31	75.6	58.1	117
280/87.04A	Skateboards	70	75.3	14.3	166
123/293	Internal combustion engines with pre- and main-combustion chambers which are interconnected via multiple passages	39	75.0	94.9	134
126/443	Solar collectors where working fluid is conveyed through tubes surrounded by a transparent enclosure	66	75.0	24.2	109
165/178	Tubular heat exchange structure with support or flow connector	33	75.0	48.5	373
123/198F	Internal combustion engines with individual cylinder disabling device	80	74.8	41.2	202
126/430	Solar heat collectors combined with heat storage and heat exchange device for use in space heating	55	74.3	20.0	84
144/326R	Mechanical shaping of wood parts by a plurality of cutting operations	43	74.1	23.3	227
126/439	Concentrating-type solar collectors having a plurality of interacting reflecting surfaces	63	74.1	12.7	107
272/67	Hand and wrist exercising equipment	34	73.9	11.8	221
5/451	Waterbeds or matresses having confined liquid	59	73.7	8.5	149
128/660	Medical diagnostic testing to detect ultrasonic radiation	101	73.7	36.6	189
123/589	Internal combustion engine charge-forming device where the amount of auxiliary air or oxygen added to the combustible mixture is controlled by the exhaust gas content	42	73.7	97.6	71
123/73A	Two cycle rear compression internal combustion engines with fuel supplied to crankcase	33	73.3	66.7	430
126/436	Solar heat collector for heating fluids circulated therethrough combined with heat storage mass	46	73.0	19.6	73
123/493	Internal combustion engine having fuel injection actuated by electronic circuit responsive to engine deceleration condition	32	72.7	75.0	67
126/419	Solar heat collectors with sensing device to control flow of working fluid or amount of solar radiation impinging on the collector	32	72.7	25.0	61
126/451	Solar heat collector with support for the article being heated	36	72.0	11.1	165
192/89B	Devices for actuating clutches which use Bellville disc springs and/or leaf springs	36	72.0	75.0	238
272/DIG4	Adjustable amusement and exercising device	36	72.0	11.1	100
84/DIG12	Rhythm and percussion accompaniment devices for musical instruments	46	71.9	45.7	101
126/446	Solar collectors where working fluid is conveyed through tubes with heat-absorbing fins or plates	51	71.8	13.7	84

FIGURE 1 – 3
TECHNOLOGY DISTRIBUTION
OF
THE TOP 50 U.S. PATENT SUBCLASSES
IN EACH EXAMINING DISCIPLINE
RANKED BY PERCENT GROWTH

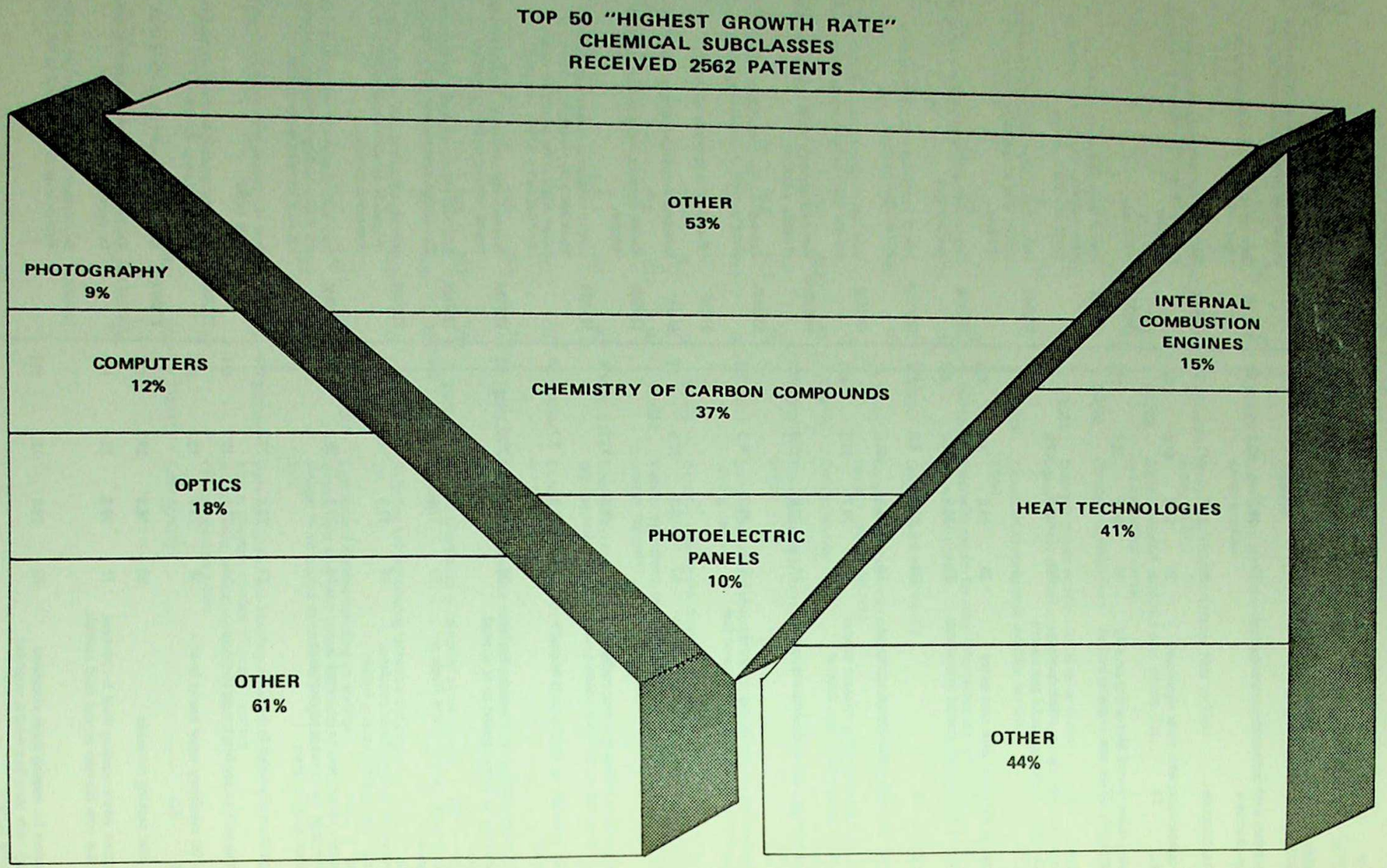


Fig. 1-3 is constructed along the same lines as Fig. 1-1. In this graph, as before, the subclasses listed in the foregoing tables were aggregated, to the greatest possible extent, into general technological categories. Note that, in this instance, the 150 ranked subclasses accounted for 8,019 of the total 666,226 patent documents added to the entire patent file during the period 1978-1980. Not only do the ranked subclasses represent a smaller share of the total 1978-1980 patents than those in Fig. 1-1, but many of the technology groupings represent small percentages of the total patenting in each discipline segment. This indicates that each of the ranked subclasses is more finely-tuned in terms of scope (i.e. most of the ranked subclasses show small numerical increases for the 3-year period), and that, as a group, the subclasses cover a wider range of diversified technologies.

Looking at each discipline, there are at least a few readily discernable patterns or trends.

Chemical Subclasses

Recalling the dominating presence of drug-related subclasses in the earlier listing by actual growth, the presence of only one subclass from class 424 in the percent growth ranking (Table B-1) is interesting and makes a significant point. It is apparent that while the drug subclasses are experiencing a great deal of activity, the recent rate of file growth in those areas is not impressive, considering file size. As pointed out previously, meaningful conclusions based upon subclass comparisons are, in some instances, difficult to make because of differences in the refinement or breakdown level of classification. Chemical subclasses, as exemplified here, are sometimes "broad" in scope and do not have the level of subject-matter breakdown extant in other technological areas.

Carbon compound technology virtually dominates the percent growth listing. Eighteen of the top 50 subclasses are directed to this technology. Referring to Fig. 1-3, it is seen that 37% of the patent documents added by the ranked chemical subclasses involved carbon compounds. Of these subclasses, eight relate to synthetic resins (Class 260, subclass 45.7PH and the 520 Series of Classes); the others being from varied and diverse areas within Class 260 and the 530-570 Series of Classes. Four energy-related subclasses from Class 136 involving photoelectric panels represent 10% of the list, another indication of high activity in solar technologies.

Mechanical Subclasses

Energy conservation and conversion technologies are again highly visible. Twenty of the subclasses in Table B-3, 41% of the added patents, relate directly to heat energy technologies. Thirteen of these, representing nearly 31% of the 2,706 patents added to the list in 1978-1980, are drawn to solar heat collectors. It is particularly interesting in this context to note that 4 subclasses from this technology appeared on the mechanical table for actual growth (Table A-3), indicating a truly emerging technology.

Internal Combustion Engine subclasses appear frequently on this list as well as in the ranking by actual growth. Six of the 50 top-ranked subclasses, representing 15% of the patents added in the three-year period, are from this category. Unusually higher-than-average values in the foreign share column, ranging from 41.2-97.6%, indicate considerable foreign activity.

Miscellaneous devices and systems from Class 405, Hydraulic and Earth Engineering, lead the mechanical listing with a growth rate of 91.9%. Three subclasses directed to seals (class 277) appear, each with growth percentage figures of above 76%.

Electrical Subclasses

Class 350, Optics, which appeared several times on the ranking by actual subclass growth, shows up six times in Table B-2. Four of these subclasses are in the area of fiber optics, reflecting the high activity and interest in that technology. Also well represented is computer technology with six subclasses in Classes 364 and 365 having percent growth rates from 71.8% to 77.9%, well above the average of 45.8%.

Semiconductor technology, so prevalent in the ranking by actual growth appears only once in this analysis, subclass 92 of Class 357, Integrated Injection Logic. Five subclasses dealing with the photographic arts (Class 354) are rated in the top 50. Not surprisingly these subclasses show high foreign activity as well.

* * *

The noted high foreign activity displayed in the foregoing tables for many of the highly active subclasses (ranked by both actual and percent growth) is highlighted in the next analysis of those U.S. Patent subclasses in which foreign resident inventors have been most active.

PART IV -- MOST FOREIGN-ACTIVE PATENT TECHNOLOGIES*

Those subclasses currently experiencing the highest percentage of foreign origin patenting were selected, and the top 50 were ranked for each of the examining disciplines, Chemical, Electrical, and Mechanical, for the three-year period 1978-1980. As a point of reference, it should be noted that the average foreign share for all U.S. patent technologies during that three-year period was 38.5%.

Although foreign origin patenting averaged only 20% of the total U.S. patenting for the years 1963-1966, the percent share has continued to increase, reaching 40% of the total for the year 1980.

TABLE SERIES C
THE MOST FOREIGN-ACTIVE TECHNOLOGIES

C-1 CHEMICAL
C-2 ELECTRICAL
C-3 MECHANICAL

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*In its Seventh Report and Eighth Report, OTAF presented an extensive two-part analysis of international patenting patterns. See also Section II of this report.

TABLE C-1. TOP 50 CHEMICAL SUBCLASSES
(Ranked by Percent Foreign Share)

Cl/Sub	Description	1978–80 Patents	% Growth	% Foreign Share	Total Patents
260/153	Azo compounds and their preparation containing a triazine nucleus	48	44.9	95.8	506
8/532	Process of dyeing polyester or cellulose fiber or dyed product thereof	40	47.1	92.5	216
260/151	Monoazo compounds and their preparation containing the phenylazonaphthyl moiety	30	46.9	90.0	479
260/239.3P	Polycyclic lactams containing 4 or more rings	38	55.9	89.5	155
260/146D	Azo compounds and their preparation containing a heavy metal or aluminum and a diazine nucleus	34	47.9	88.2	93
8/648	Dye composition, process or dyed product where a fluorescent dye, an optical brightener or a blueing agent is applied as a dye	32	38.6	87.5	234
526/906	Processes involving the comminution of transition metal containing polymerization catalysts	40	65.6	87.5	155
260/162	Azo compounds and their preparation containing a pyrazole nucleus and 1 azo group	53	47.3	86.8	509
260/117	Proteinaceous compounds which are gelatin, glue or their reaction products	36	48.6	86.1	507
526/119	Polymerization of only ethylenic monomers in the presence of 1) two or more different compounds of the same transition metal, and 2) a non-transition elemental metal, hydride or carbon derivative thereof	33	68.7	84.8	127
546/224	Piperidines containing an additional ring, nitrogen attached directly to piperidine ring, and acyclic nitrogen bonded directly to carbonyl	33	57.9	84.8	131
260/155	Heterocyclic azo compounds and their preparation containing a quinoline moiety	58	40.8	84.5	553
260/149	Monoazo compounds and their preparation containing a heavy metal or aluminum	32	49.2	84.4	314
548/377	Pyrazoles with chalcogen, halogen, or nitrogen attached directly to the ring and additional chalcogen, halogen, or nitrogen attached through carbon	31	59.6	83.9	103
8/611	Dye composition with alcohol additive, process using the composition, or dyed product formed from the composition	30	36.6	83.3	412
260/205	Compounds which contain a phenylazophenyl moiety, and preparations thereof	59	41.5	83.1	643
544/25	Compounds having cepham or cephem as two cyclos of a bicyclo ring system, a 3-position pyridine containing substituent and a 7-position hetero ring containing substituent	46	41.4	82.6	165
75/125	Iron–copper alloys	34	44.7	82.4	682
260/147	Azo compounds and their preparation containing a heavy metal or aluminum and a pyrazol group	51	51.5	82.4	587
261/50A	Fluid distribution apparatus with suction-operated gas inlet valve connected to liquid inlet valve	54	51.4	81.5	750
260/146R	Azo compounds and their preparation containing a heavy metal or aluminum and a heterocyclic group	59	48.8	81.4	1112
260/157	Azo compounds and their preparation containing an azole group	56	40.3	80.4	558
106/100	Processes of making portland cement	61	56.0	80.3	510
260/196	Monoazo compounds and their preparation containing a naphthylazophenyl group	34	39.5	79.4	542
544/22	Compounds having cepham or cephem as two cyclos of a bicyclo ring system and containing an additional hetero ring	68	39.8	79.4	223
260/207.1	Monoazo compounds which contain a phenylazophenyl moiety and a carbonyl moiety which is not an aldehyde or ketone carbonyl, and preparations thereof	61	43.6	78.7	540
260/154	Azo compounds and their preparation containing a diazine nucleus	74	41.8	78.4	584
544/28	Compounds having cepham or cephem as two cyclos of a bicyclo ring system, an alkyl, hydroxy-, alkoxy-, or alkanoyloxy-alkyl bonded at 3-position, and an additional hetero ring	111	39.9	78.4	440
526/351	Polypropylene resins and preparations thereof	78	53.4	78.2	710
544/105	Compounds with bicyclo ring system having 1,4 oxizine as one of the cyclos (e.g., benzoxazines)	32	46.4	78.1	165
260/314.5	Phthalocyanines and their preparation, useful as dyes	45	44.1	77.8	762
260/208	Processes for treating azo compounds (e.g., to convert them into compounds of different character or to purify them)	49	52.1	77.6	422
260/158	Azo compounds and their preparation containing a thiazole nucleus	71	40.8	77.5	747
75/60	Treatment of molten iron or iron alloys with oxygen or other gaseous oxidizing agents to produce steel (e.g., basic oxygen process)	69	43.4	76.8	805
260/156	Azo compounds and their preparation containing a pyridine group	112	43.6	76.8	565
424/341	Drugs and bioaffecting compositions where the active ingredient is a polyoxyether	43	34.4	76.7	363
75/59	Gaseous treatment of molten iron or iron alloys	30	40.5	76.7	286
546/271	Pyridine compounds containing polycyclo hetero ring system having plural ring nitrogens	30	34.5	76.7	180
260/40P	Melt spun polyester resins with filler, dye or pigment	33	41.8	75.8	137
260/207	Monoazo compounds which contain a phenylazophenyl moiety, a phenolic-oxy moiety and a carbonyl moiety which is not an aldehyde or ketone carbonyl, and preparations thereof	65	44.8	75.4	588
526/125	Polymerization of only ethylenic monomers in the presence of 1) a transition metal or compound thereof, 2) a halogen-containing Group IA or IIA metal compound where the metal is not bonded to hydrogen or carbon, and 3) a non-transition elemental metal, hydride or carbon derivative thereof	97	76.4	75.3	249
148/31.57	Permanent magnetic metal compositions	40	43.0	75.0	287
260/206	Monoazo compound which contains a phenylazophenyl moiety and a phenolic-oxy moiety, and preparations thereof	44	34.4	75.0	612
260/326.1	Isoindoles and preparations thereof	39	40.6	74.4	266
8/527	Dye concentrate composition wherein an additional amount of a constituent must be added before use	31	56.4	74.2	129
430/505	Image-producing product having 2 or more layers radiation sensitive to different spectral regions and containing developing inhibitor or processing ingredient	31	37.8	74.2	235
260/163	Preparation of monoazo, pyrazole-containing compounds from monocyclic diazo component	58	48.3	74.1	719
546/201	Piperidine compounds containing an indole or hydrogenated indole moiety	38	52.1	73.7	213
544/370	Piperazines containing a 1,3-diazole ring	34	50.0	73.5	144
8/471	Diffusion transfer dyeing process using dry heat to facilitate dye penetration and involving sublimation in the transfer	60	63.8	73.3	115

TABLE C-2. TOP 50 ELECTRICAL SUBCLASSES
(Ranked by Percent Foreign Share)

Cl/Sub	Description	1978-80 Patents	% Growth	% Foreign Share	Total Patents
354/60A	Camera with light responsive device and oscillator	33	49.3	100.0	70
354/23D	Camera including photoelectric light responsive device and digital circuit	95	59.7	98.9	201
354/38	Camera including light detector which controls shutter or diaphragm	47	59.5	97.9	179
354/289	Camera setting indicators	94	76.4	95.7	227
354/60L	Camera with photoelectric light responsive device and lamp-type electrical indicator	83	62.9	94.0	146
354/106	Exposure identification camera	30	78.9	93.3	143
354/31	Camera with plural light detectors	50	54.9	92.0	194
354/60R	Camera with light responsive device and other electric circuit means	61	39.9	91.8	466
354/53	Camera with photoelectric light responsive device and indicator visible in the view finder	60	65.2	91.7	144
354/286	Camera lens mounts	33	55.0	90.9	121
354/149	Camera exposure control linked with flash	43	59.7	90.7	128
354/152	Reflex camera with single objective	45	50.6	88.9	193
354/173	Camera with electric film advance	63	54.3	88.9	228
354/51	Camera with light responsive shutter control including electric circuit with capacitor	55	32.0	87.3	356
368/187	Time measuring devices with electrical rate regulation	39	73.6	87.2	141
354/234	Dynamo-electric actuated camera shutter	59	61.5	84.7	207
368/85	Chronological time measuring devices with pulse transforming means	32	76.2	84.4	59
354/33	Camera with light responsive flash control circuits	50	59.5	84.0	160
274/15R	Record turntable with automatic tone arm return	37	77.1	83.8	452
354/266	Camera shutter release or actuator means	47	61.0	83.0	202
219/69M	Methods of metal cutting or machining with an electric arc	35	42.7	82.9	222
354/50	Camera shutter control by light responsive electric circuit means	39	34.2	82.1	250
250/311	Inspection of solids or liquids by electron microscope	53	49.5	81.1	372
315/39.51	Distributed parameter resonator-type magnetron circuit	35	49.3	80.0	292
368/82	Chronological time measuring devices with electro-optical displays	35	67.3	80.0	80
354/219	Camera view finders	34	54.0	79.4	227
315/241P	Photoflash devices with a condenser in shunt to the load and the supply	53	40.5	79.2	443
354/25	Automatic, photo-electric camera focus control	102	62.6	77.5	226
355/3TR	Electric photography (photocopying) transfer toner image	57	58.7	77.2	65
340/765	Liquid crystal visual display communication systems	48	46.2	77.1	142
368/29	Time measuring devices with electro-optical calendar indicators	30	61.2	76.7	61
340/811	Selective visual display communication systems with specified display energizing means	33	31.4	75.8	257
352/27	Motion picture cameras recording picture and sound on a common film	41	58.6	75.6	145
354/187	Folding, collapsible or bellows cameras	36	65.5	75.0	254
355/10	Electric photography (photocopying) with liquid developing	56	37.3	75.0	424
368/204	Electrical power supplies for time measuring devices	44	48.9	75.0	197
354/59	Camera photo-electric device with pre-detector light modifier	39	57.4	74.4	130
310/268	Electric generators or motors with disc-type armatures	42	51.2	73.8	572
360/134	Magnetic tape	30	62.5	73.3	172
250/416TV	X-ray television	37	66.1	73.0	74
354/145	Camera with synchronized electronic flash	70	62.5	71.4	250
315/408	Cathode ray tube circuits including a deflection coil with a solid state switch	59	56.7	71.2	163
360/137	Miscellaneous dynamic magnetic information storage or retrieval	97	55.4	71.1	310
350/333	Optics system utilizing liquid crystal with electrical circuit driving row and column electrodes	31	52.5	71.0	72
354/62	Eye, mouth or body photography	41	75.9	70.7	150
335/213	Electron or ion beam deflecting electromagnet coil structure	34	54.8	70.6	270
274/23R	Record player tone arms	64	67.4	70.3	772
179/18GF	Selector circuits for automatic, central telephone switching systems using matrix, non-relay cross points	37	46.8	70.3	267
315/151	Radiant energy sensitive controls responsive to a load device	40	44.4	70.0	300
333/28R	Wave transmission line coupling networks with equalizers	30	37.0	70.0	823

TABLE C-3. TOP 50 MECHANICAL SUBCLASSES
(Ranked by Percent Foreign Share)

Cl/Sub	Description	1978–80 Patents	% Growth	% Foreign Share	Total Patents
57/263	Apparatus and processes for piecing up textiles on an open-end machine	46	56.1	100.0	112
172/59	Plural, driven, laterally spaced earthworking tools having vertical axes	72	50.7	98.6	282
123/589	Internal combustion engine charge-forming device where the amount of auxiliary air or oxygen added to the combustible mixture is controlled by the exhaust gas content	42	73.7	97.8	71
123/293	Internal combustion engines with pre- and main-combustion chambers which are interconnected via multiple passages	39	75.0	94.9	134
29/116AD	Rolls or rollers rotatable relative to a support shaft, with an anti-deflection feature	36	59.0	94.4	138
68/5E	Machines with chamber seal for treating textiles with a gas, steam or mist	32	47.8	93.7	234
242/47.01	Unidirectional cord-winding device	31	46.3	93.5	153
123/280	Internal combustion engines having pre- and main-combustion chambers with ignition particularly positioned relative to the chambers	49	59.8	91.8	209
57/58.95	Free-end yarn-spinning device combined with mechanical feeding means	35	31.5	91.4	260
303/24F	Proportioning inertia control device for use in fluid pressure brake or analogous system	31	70.5	90.3	106
60/290	Internal combustion engines with chemical treatment of exhaust gas where air feed to reactor is controlled in response to engine speed or intake manifold pressure	71	59.2	90.1	189
57/58.89	Free-end yarn-spinning device	67	40.1	89.6	345
60/285	Internal combustion engine with fuel, air or ignition controlled by exhaust gas reactor condition	81	60.4	88.9	190
308/6C	Bearing structure in which anti-friction feature is a recirculating fluid	33	44.0	87.9	177
280/605	Skis with pivotal mounted brake member	57	64.8	87.7	133
299/43	Sidewall working mining machines with material-handling means	53	69.7	86.8	172
123/432	Internal combustion engines having combustion chambers with plurality of inlets for air or combustible mixture	30	62.5	86.7	133
303/119	Fluid pressure brake with speed responsive solenoid-operated cut-off and release valve	30	45.5	86.7	138
139/435	Textile weaving with stationary weft supply where weft is inserted by fluid jet	36	64.3	86.1	136
60/278	Internal combustion engines using recycled exhaust as portion of fuel source	35	46.7	85.7	148
60/282	Internal combustion engine where a chemical reaction of a component of exhaust gas is produced	48	40.0	85.4	174
60/323	Internal combustion engine having a common exhaust receiver from plural cylinders (i.e., exhaust manifold)	34	47.2	85.3	209
188/73.5	Retainer for axially movable wheel brake element which prevents vibration of element	32	45.7	84.4	141
297/483	Shoulder harness type safety belts	32	49.2	84.4	141
164/448	Roller device for support or withdrawal of products in continuous casting apparatus	38	55.9	84.2	105
303/6C	Fluid pressure brakes where fluid is distributed to multiple motors which modify front and rear pressure	83	51.2	83.1	525
280/618	Ski with toe and heel fastener plate releasable from ski	52	43.7	82.7	185
60/276	Internal combustion engine where exhaust gas composition is analyzed	139	67.1	82.0	255
152/362R	Pneumatic tires with reinforced rim bead structure	46	51.1	80.4	577
24/205.16C	Separable, slider-type fasteners having wire mounting structure	30	41.7	80.0	177
123/407	Internal combustion engines using a vacuum to control timing of ignition spark	38	52.1	78.9	298
60/299	Internal combustion engines with catalytic treatment of exhaust gas and device to cool reactor or reactor feed	32	41.0	78.1	223
242/18DD	Drum driven bobbin and cop winding devices	40	44.0	77.5	271
123/416	Internal combustion engines having digital electronic control of spark ignition timing	57	62.6	77.2	100
303/22R	Load control fluid-pressure brakes	61	50.0	77.0	539
432/14	Material heating operation including passing gas into or through particulate work	52	52.0	76.9	267
432/106	Rotary drum furnaces with plural work chambers in series	52	46.4	76.9	342
123/489	Internal combustion engine having fuel injection actuated by electronic circuit responsive to condition of the exhaust gas	103	71.5	76.7	152
36/117	Ski boots	30	53.6	76.7	141
152/354R	Carcass material arrangement for pneumatic tires	55	48.7	76.4	521
123/568	Internal combustion engine charge-forming device where exhaust gas is mixed with combustible mixture (e.g., emission control valve)	211	58.9	75.8	731
123/418	Internal combustion engine where timing of ignition spark is speed responsive	49	55.7	75.5	182
16/163	Hinges with multiple pins	32	71.1	75.0	75
74/866	Interrelated motor and transmission control via accelerator actuated electric signals	44	51.8	75.0	236
123/195C	Internal combustion engine frame construction with covers	36	69.2	75.0	100
123/493	Internal combustion engine having fuel injection actuated by electronic circuit responsive to engine deceleration condition	32	72.7	75.0	64
192/89B	Devices for actuating clutches which use Belleville disc springs and/or leaf springs	36	72.0	75.0	236
242/199	Reeling and unreeling web material carrying machine-convertible information including a cartridge which encloses reel pair	63	47.7	74.6	346
123/571	Internal combustion engine charge-forming device with electronic control of emission control valve	59	66.3	74.6	134
123/440	Internal combustion engines having electronic exhaust gas responsive control of carburetor fuel metering	175	79.2	74.3	236

As shown in Table Series C, the top 50 Chemical subclasses in this category ranged in foreign share from 73.3 to 95.8%; Electrical, 70% to 100%; Mechanical, 74.3% to 100%.

Aggregating the subclasses generally by technology within each of the noted disciplines provides the input for the graphical presentation shown in Fig. 1-4. Displayed as a segmented "Foreign Pipeline" cross-section is a technology breakdown of the top 50 foreign-active subclasses in each discipline. The percentages represent the number of subclasses, rather than the number of patents, which appear in the indicated technologies.

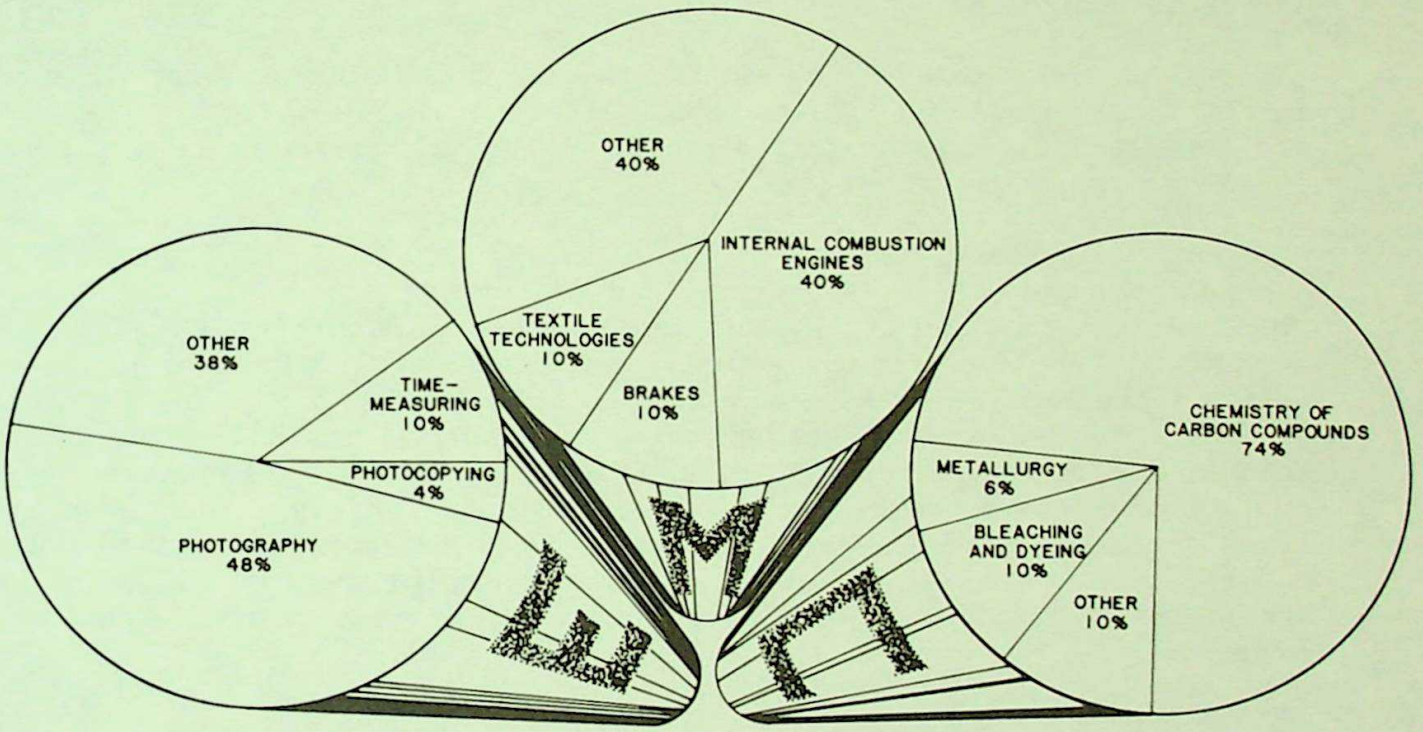

FIGURE 1 - 4

THE FOREIGN PIPELINE
TECHNOLOGY DISTRIBUTION
WITHIN TOP 50 SUBCLASSES
RANKED BY PERCENT FOREIGN SHARE
ELECTRICAL, MECHANICAL, CHEMICAL

Chemical Subclasses

The chemical area is dominated by the presence of 37 subclasses, an impressive 74%, dealing with organic compounds, classified within Class 260, the 520 and 530-570 Series of Classes. Of these, five subclasses involve the chemistry of synthetic resins. Many others, including 19 dealing with azo-containing compounds, relate to chemicals which are used primarily as dyestuffs. The related areas in Class 8, directed to dyeing compositions

and methods, make up another 10% of the subclasses in Table C-1. The dye industry is an area where foreign countries such as Germany and Switzerland have long been active.

Electrical Subclasses

Photography, an area consistently dominated by foreign resident inventors, takes the lead in the electrical subclasses by an overwhelming margin. Twenty-four of the top 50 subclasses, and the first fourteen subclasses listed, are from Class 354, Photography. Also in Table C-2 are two subclasses from Class 355, Electric Photography (photocopying). Of these 26 subclasses, 18 list foreign shares above 80%, more than twice the average for all technologies.

The second major category within the Electrical discipline is Time Measuring Systems and Devices (Class 368), five subclasses of which made the top 50 list. Foreign resident inventor shares in these subclasses during 1978-80 range from 75% to 87.2%.

Mechanical Subclasses

As shown in Fig. 1-4, the automotive industry dominates the Top 50 mechanical list when foreign activity is the measure. Subclasses directed to the technology of internal combustion engines make up 40% of the Top 50 list. Related areas, such as tires, brakes, clutches and safety belts account for an additional 20% of the listed subclasses. The above data should come as no surprise considering the recent heavy involvement by Japan in this industry. Also not unexpected is the presence of five subclasses directed to textile industry, which not unlike the dyestuff technology in the chemical area, has historically been an area of high foreign involvement.

* * *

CONCLUSION

"Active Technologies," now a periodic feature in OTAF publications, continues to identify those technological areas having both new and sustained activity. This section makes possible the examination of technology at the subclass level of the U.S. Patent Classification System, a system which continues to change to meet the needs of its users. While many of these changes are reflected by the presence of new entries on the activity lists, other subclasses have consistently appeared, and certain trends have remained fairly constant. The ability to document and analyze both established trends and emerging patterns across the entire spectrum of technology, hopefully, will prove invaluable in the study of technological development.

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TECHNOLOGY ASSESSMENT & FORECAST

The Patent System added the
interest to the fire of genius.

SECTION II - PATENT TRENDS
Foreign Multinational Patenting Trends in the U.S.

Introduction 35

The Universe 37

Results

- General Characteristics 37
- Correlation Between Sales and Patenting 38
- Dominance in International Technology Market 38
- Patents Originating in the U.S. 43
- Technology Trends 43

INTRODUCTION

In this section, OTAF expands its analysis of foreign patent activity in the U.S. beyond U.S. patents with foreign resident inventors (the criterion used in Section I). Covered here, in addition, are U.S. origin patents assigned to U.S. enterprises that are owned or controlled by foreign organizations. While the former reflects technological activity in other countries,* the latter must also be considered if the issue is foreign influence in the U.S. technology market.

In recent years the United States has become increasingly attractive as a host country to foreign multinational corporations** (FMNCs). In the decade ending in 1973, the growth rate of foreign direct investment in the U.S. averaged around 6 percent per annum; whereas, since 1973, it has been increasing at an average rate of 20 percent. Although the U.K., Canada, and the Netherlands account for four-fifths of the foreign investment into the United States, there has also been a rapid expansion in investment from Japan, France, and Germany.***

With this rapid growth in FMNC direct investment in the domestic economy, more U.S. patented technology may be controlled by foreign interests. This study begins to look at the impact of foreign multinational corporations to (1) determine their influence in the U.S. technology market and (2) discern information about the invention and innovation interests of these firms. Because the U.S. is such a sought after market, many, if not all, the major developments of FMNCs are likely patented in the United States. Hence, the U.S. patent file may be an especially valuable resource for this information.

Objectives

In this initial study, the focus will be on some of the largest foreign multinational corporations (FMNCs) in the world. Of interest are such questions as: How much U.S. technology do they control? How much of their R&D is performed in this country? In what technologies do they patent? And finally, what is the trend in their technological activity as evidenced by U.S. patenting?

The study has two objectives. First, the data developed are intended to contribute to an understanding of international technology development. Second, insight is sought into whether the refinement of foreign patent activity data to the firm level and by ownership can be beneficial both to U.S. business, which needs to know what the competition is doing, and to the U.S. Government, which must base its trade and export promotion policies on the best available information.

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*See page 2 of the Introduction to this publication for discussion of patents and patent activity.

**A multinational corporation is defined as an enterprise which owns assets and controls activities in different countries.

***N. Hood and S. Young, The Economics of Multinational Enterprise, Longman (London and New York), 1979, p. 24.

TABLE 2-1

10 FOREIGN MULTINATIONAL CORPORATIONS:
COUNTRY, PATENTS, SALES

Foreign Multinational Corp. (FMNC)		Country[1]	No. of Patenting Subsidiaries & Affiliates[2]	No. of Patents 1969-1980	Sales Data[3]		
					Sales ($Million)	Ranking in 10 FMNC	Ranking in FORTUNE 500
Bayer A.G.[4]	(Bayer)	West Germany	22	7289	15881	4	16
Philips Gloeilampenfabrieken	(Philips)	Netherlands	38	5611	18403	1	10
Ciba-Geigy A.G.[4]	(C-G)	Switzerland	17	5231	7133	8	52
Siemens A.G.[4]	(Siemens)	West Germany	22	4748	17950	2	12
Hoechst A.G.[4]	(Hoechst)	West Germany	27	4048	16481	3	15
Hitachi Ltd.	(Hitachi)	Japan	18	3591	12871	5	26
Matsushita Electric Industrial Co., Ltd.	(MEI)	Japan	9	2709	12684	6	27
Fuji Photo Film Co. Ltd.	(Fuji)	Japan	2	1928	1947	10	239
Toshiba Corp.	(Toshiba)	Japan	15	1566	8146	7	42
Sony Corp.	(Sony)	Japan	3	1378	3790	9	126

[1]Country of parent
[2]Including parent
[3]Sales and sales rankings are from the August 10, 1981 edition of FORTUNE, "The FORTUNE Directory of the Largest Industrial Corporations Outside the United States." Sales figures are for the year ending Dec. 31, 1980, unless otherwise noted in the FORTUNE article.
[4]A.G.= Aktiengesellschaft

THE UNIVERSE

This initial study focuses on a very select universe of FMNCs: the five European and the five Japanese corporations with the greatest number of patents granted in the U.S. for the years 1969 through 1980, hereafter referred to as 10FMNCs. Patents attributed to a FMNC include (1) patents to wholly owned subsidiaries, and (2) patents to affiliates of which the parent controls more than 50 percent. So called "associates" -- companies of which a parent owns 50 percent or less -- were not included in the patent count. Subsidiaries and affiliates of the 10FMNC which were considered were those identified, for the most part, by matching FMNC owned companies listed in Who Owns Whom (Dun and Bradstreet, 1981 edition) and the 1980 Moody's Industrial Manual against the OTAF data bank containing the names of assignees which patent in the U.S.*

The 10FMNCs in this study are the top European and Japanese patenting corporations for the entire period, years 1969-1980. Although the study examines the activity of these 10FMNCs for shorter periods, it should be borne in mind that the 10FMNCs identified for this study are not the top twenty for these shorter time periods. The composition and ranking of the 10 corporations is dependent on the time period chosen. Selection of a different period would likely result in a different universe of FMNCs.

It should also be kept in mind that the 10FMNC universe is both very small and very select and, therefore, not necessarily representative of FMNCs in general. Thus, the data in this analysis can provide insight into the technology activity and trade inclinations of the 10FMNCs, only. Generalization should be avoided.

Appendix A1 contains tables of data relied upon in this Section. Included are patent activity tables showing, by date of patent grant, the number and origin of patents for each enterprise for each year 1969-1980. General categories of assignment, e.g., U.S. corporate owned, foreign corporate owned, are also given.

Other data tables in Appendix A1 show, for the ten firms included in this study, individually and in Japanese and European groupings, the number of patents granted in specified classes within the U.S. Patent Classification System for each year 1969-1980.

RESULTS

General Characteristics of FMNCs

Table 2-1 ranks the 10FMNCs by number of patents and lists their country, number of patents (1969-1980), number of affiliates or subsidiaries, and sales in 1980. Of the five European firms, three are West German, one Swiss and one Dutch.

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*OTAF would like to acknowledge the assistance of the Canadian Department of Consumer and Corporate Affairs. The information which they furnished regarding the parent-subsidiary relationship of enterprises patenting in Canada was used as a resource for this study.

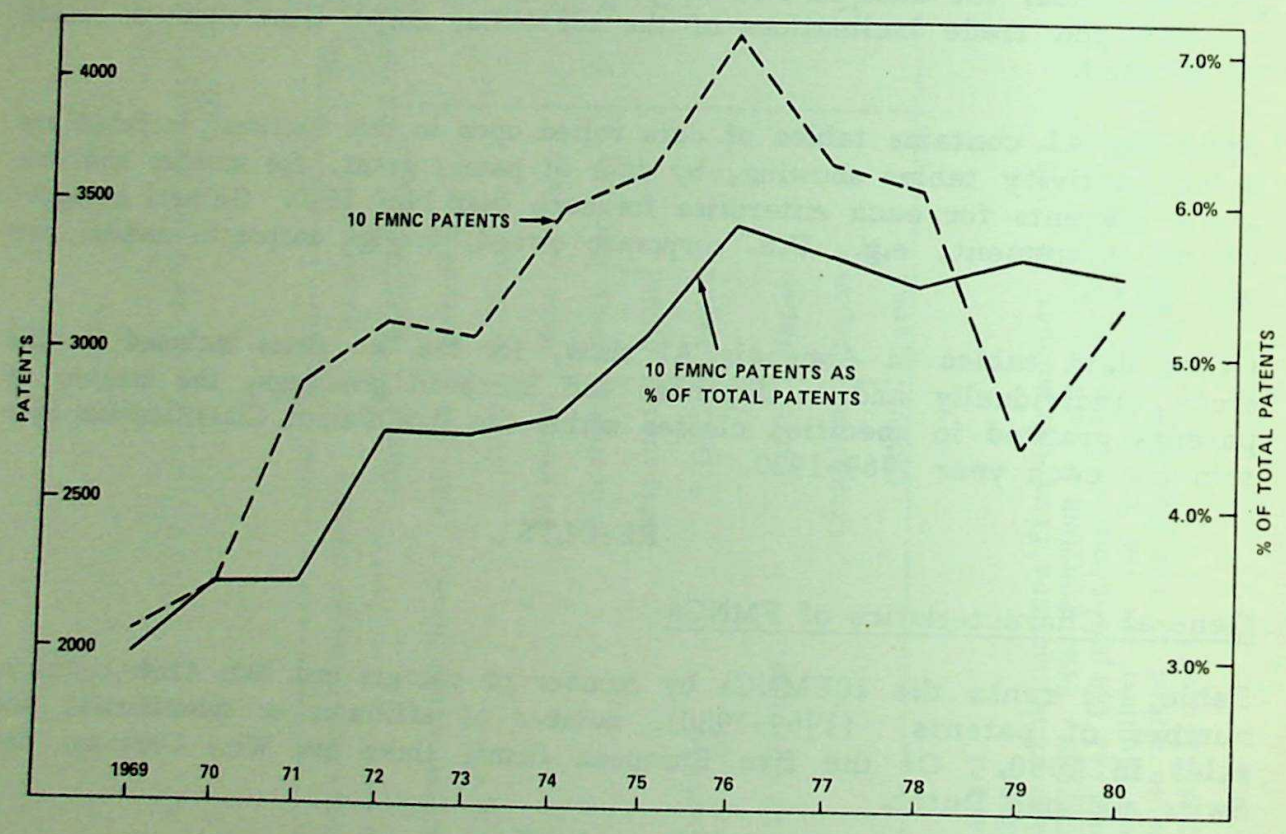
Correlation Between FMNCs Sales and Patenting

Sales data in Table 2-1 are derived from the August 10, 1981 edition of FORTUNE and, unless otherwise noted in that edition of the magazine, are for the year ending Dec. 31, 1980. Besides actual sales amounts, the 10FMNCs are ranked (1) amongst themselves by sales and, for perspective, (2) within the FORTUNE "Foreign 500." As might be expected, correlation between ranking by patents and sales is strong. The top five 10FMNCs in sales are within the top six rated by patents. Within the "Foreign 500," the 10FMNCs range from Philips at number two in sales ($18.403 billion) to Fuji at number 239 ($1.947 billion). For all 10FMNCs, the average sales figure is $11.528 billion.

Dominance in International Technology Market

A comparison of 10FMNC patenting with total patenting in the U.S. for the period 1969-1980 is shown in Figure 2-1. The 10FMNC share of all U.S

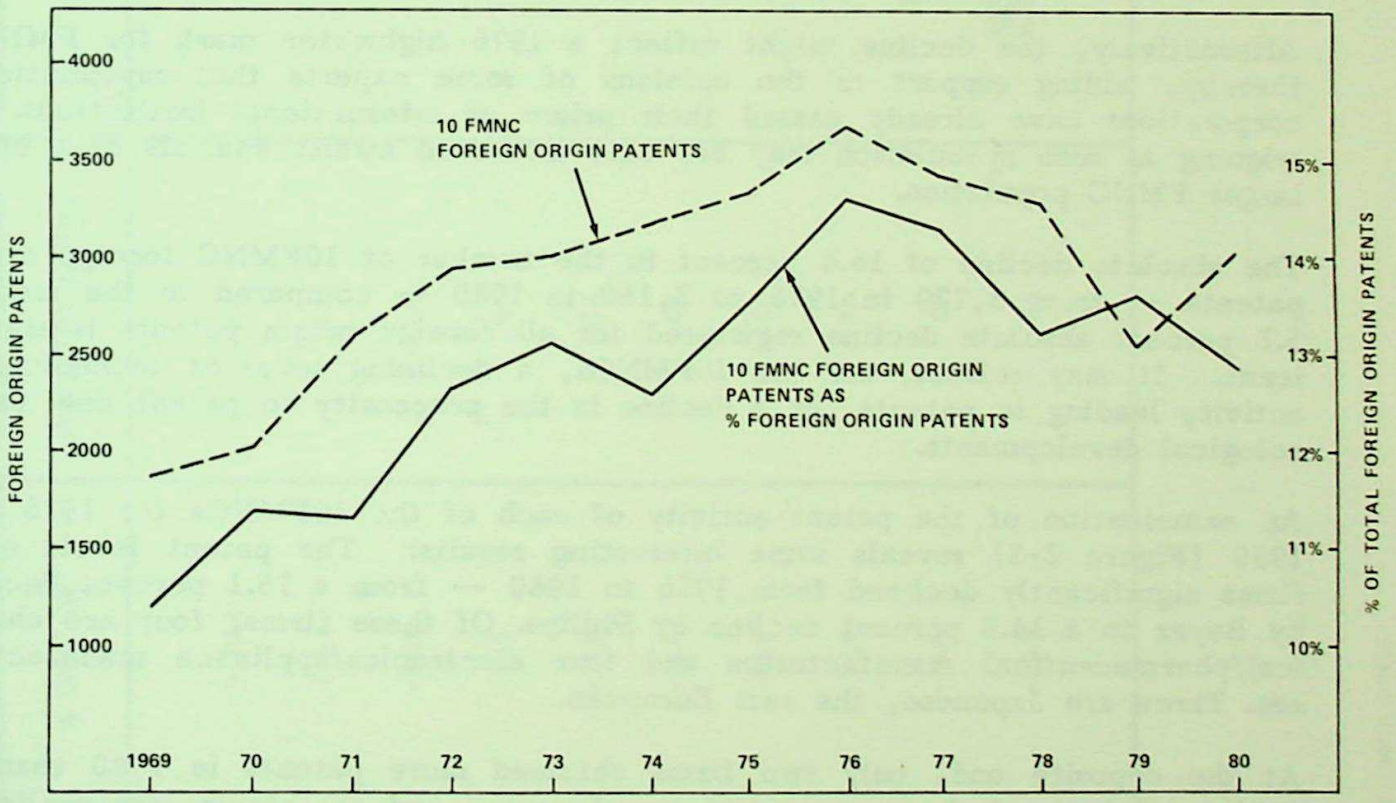
FIGURE 2-1
U.S. PATENT ACTIVITY OF 10 FOREIGN
MULTINATIONAL CORPORATIONS (1969-1980)



patents rises from 3.0 percent (2,031 patents) in 1969 to 5.5 percent (3,381 patents) in 1980, having leveled out following a peak of 5.8 percent (4,073 patents) in 1976.* Three outstanding points are noted. First, the 10FMNCs together own or control, on the average, 4.7 percent of all U.S. patents granted each year. This is a surprisingly large number considering that the 173 parent, subsidiary, and affiliate companies represented by the 10FMNCs are only 0.27 percent of all the 65,000 companies listed as having been assigned, at time of issue, patents granted in the U.S. since 1969. Second, the extent of that ownership nearly doubles from 1969 to 1976; and third, it stabilizes at about 5.6 percent after 1976.

The rise may not be all that unexpected in as much as it may reflect intensifying foreign competition. However, the third point -- the post 1976 stabilization -- is intriguing, especially alongside data evidenced in Figure 2-2.

FIGURE 2-2
FOREIGN ORIGIN PATENT ACTIVITY OF 10
FOREIGN MULTINATIONAL CORPORATIONS (1969-1980)



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*In 1979, Patent and Trademark Office issued substantially fewer patents than normal due to lack of funds to print patents. Therefore, while the 1979 patent grant data may be low, the decrease should not be attributed to a fall-off in technological activity. This aberration in the number of patents granted in 1979 has little or no effect on percentage breakouts for any particular category of patents (e.g., percent total patents.)

Figure 2-2 plots the foreign origin activity of 10FMNCs as a percent of all foreign origin patenting in the United States. Foreign origin patents are those where the residence of the first listed inventor is somewhere other than in the United States. Here the rise, peak, and subsequent decline of 10FMNC patenting performance matches up well with data in Figure 2-1. Overall, 10FMNC patent ownership of all foreign origin U.S. patents rises from 10.5 percent (1,805 patents) in 1969 to a mid-period peak of 14.6 percent (3,779 patents) in 1976, followed by a decline to 12.9 percent (3,160 patents) in 1980. The data show that about 1 in every 8 U.S. patents of foreign origin is owned or controlled by only 10 FMNCs, an indication of the strong position of a few large FMNCs in the international technology marketplace.

What is the cause of the post 1976 percent (relative) stabilization or decline that appears in both Figures 2-1 and 2-2? One possible explanation for the decline in percentage of total foreign origin patents to 10FMNCs may be that the patenting level of all non-universe foreign entities is growing relatively faster than that of the 10FMNCs. It is a fact that foreign origin patents increased from 20 percent of all U.S. patents in 1963-66 to 40 percent in 1980.

Alternatively, the decline might reflect a 1976 highwater mark for FMNCs; thereby, adding support to the opinions of some experts that multinational corporations have already passed their prime as international institutions.*Intriguing as such speculation may be, safe inference awaits analysis of a much larger FMNC population.

The absolute decline of 16.4 percent in the number of 10FMNC foreign origin patents -- from 3,779 in 1976 to 3,160 in 1980 -- compared to the modest 5.7 percent absolute decline registered for all foreign origin patents is significant. It may reflect, for the 10FMNCs, a declining level of technological activity leading to patents, or a decline in the propensity to patent new technological developments.

An examination of the patent activity of each of the 10FMNCs for 1976 and 1980 (Figure 2-3) reveals some interesting results: The patent levels of 8 firms significantly declined from 1976 to 1980 -- from a 15.1 percent decline by Bayer to a 34.2 percent decline by Philips. Of these firms, four are chemical/pharmaceutical manufacturers and four electronics/appliance manufacturers. Three are Japanese, the rest European.

At the opposite end, only two firms obtained more patents in 1980 than in 1976, and both of these companies are Japanese and are electronics/appliance manufacturers. Toshiba performed outstandingly, increasing its patents 168.4 percent beyond the 1976 level.

Factors contributing to the declines may result from a variety of causes, some perhaps company specific, others possibly reflective of some general long term or temporary trend. Additional analysis is needed to determine the factors influencing these statistics.

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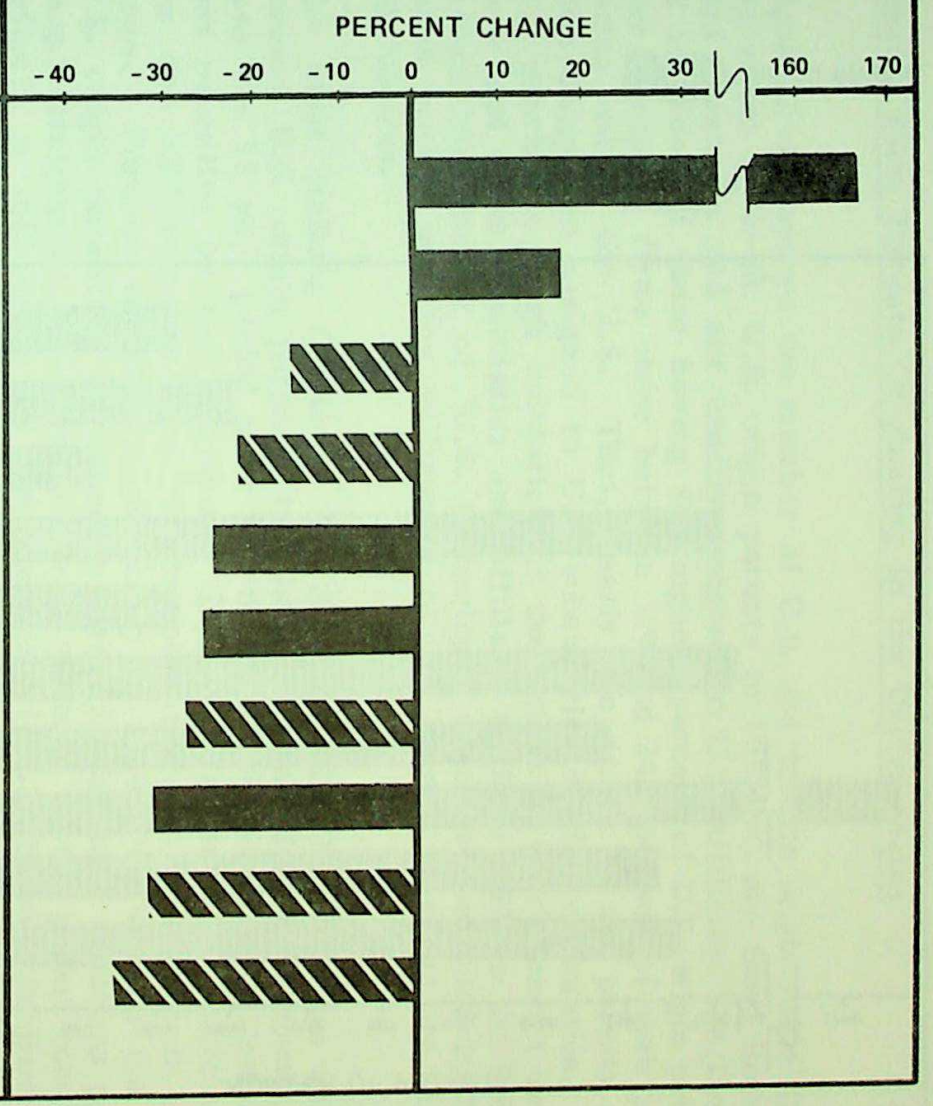
*N. Hood and S. Young, The Economics of Multinational Enterprise, Longman (London and New York), 1979, p. vii.

FIGURE 2-3
PERCENT CHANGE IN THE NUMBER OF PATENTS
1980 vs. 1976 FOR 10 FMNC

FMNC	% CHANGE[1]	INDUSTRY GROUP[2]
TOSHIBA	+168.4	EA
HITACHI	+13.4	EA
BAYER	-15.1	CP
SIEMENS	-21.5	EA
SONY	-23.5	EA
FUJI	-24.5	CP
HOECHST	-26.6	CP
MEI	-30.4	EA
C-G	-30.6	CP
PHILIPS	-34.2	EA



JAPANESE

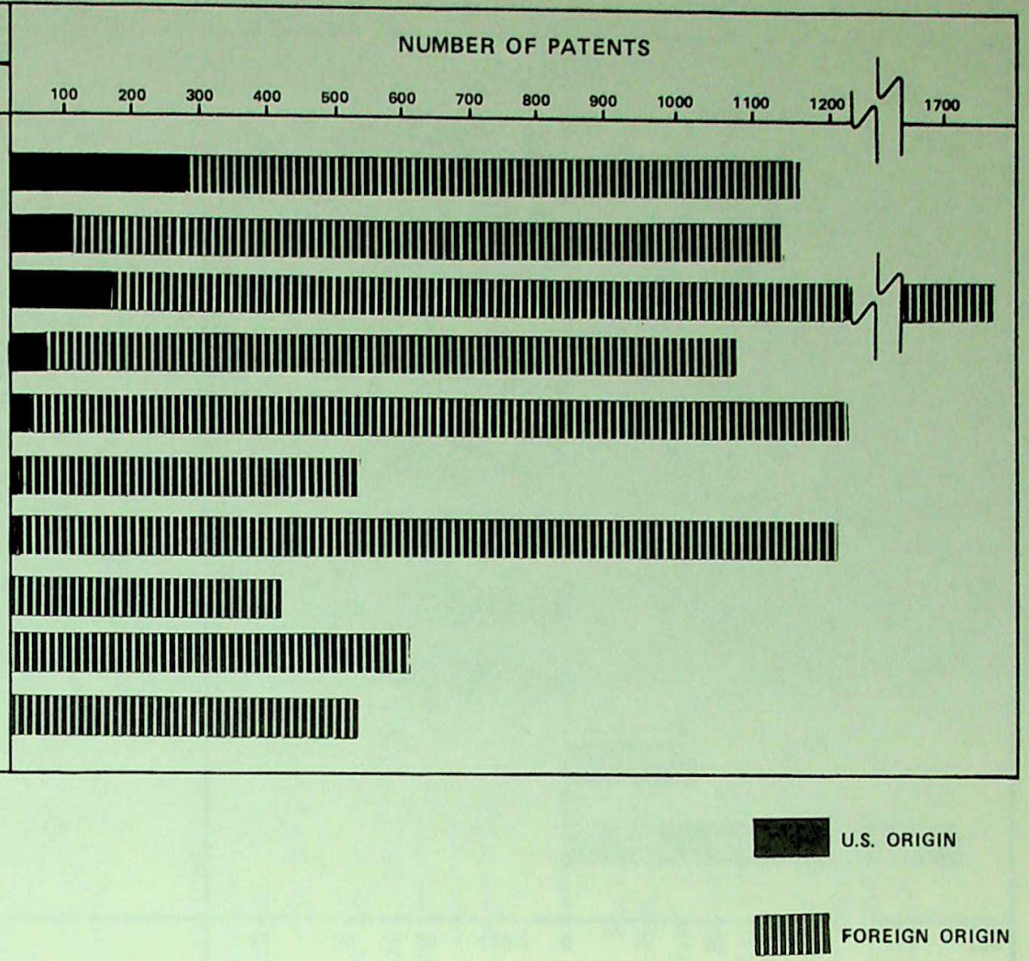
EUROPEAN

[1] PERCENT CHANGE = (1980 - 1976) ÷ 1976

[2] EA – ELECTRONICS & APPLIANCES
CP – CHEMICAL & PHARMACEUTICAL

FIGURE 2-4
U.S. ORIGIN FMNC PATENTS
VS.
TOTAL FMNC PATENTS (1978-1980)

FMNC	COUNTRY OF PARENT CORP	% PATENTS U.S. ORIGIN	NUMBER OF PATENTS	
			U.S. ORIGIN	TOTAL
C-G	SWITZERLAND	24.2	281	1159
PHILIPS	NETHERLANDS	9.9	113	1137
BAYER	WEST GERMANY	9.4	167	1780
HOECHST	WEST GERMANY	6.4	69	1080
SIEMENS	WEST GERMANY	1.9	24	1236
MEI	JAPAN	1.1	6	529
HITACHI	JAPAN	0.6	8	1213
SONY	JAPAN	0.2	1	418
TOSHIBA	JAPAN	0	0	608
FUJI	JAPAN	0	0	520



Foreign Firm Patents Originating in the United States

Figure 2-4 displays the number of U.S. and foreign origin 10FMNC patents for the years 1978-80. U.S. origin patents to 10FMNC are those having U.S. resident inventors and are usually assigned to U.S. affiliates. The firms are ranked in order of those having the highest percent of U.S. origin patenting. The five European firms show between 1.9 and 24.2 percent of their patents originating within the U.S. Thus, nearly one fourth of the patents attributed to Ciba-Geigy are assigned to U.S. subsidiaries of that corporation. These data may provide a rough indication of the extent to which foreign owned corporations and their subsidiaries and affiliates perform R&D in the U.S. They also reflect the amount of "U.S. technology" which is controlled by the foreign-based parent and the willingness of the parent to assign its patents to U.S subsidiaries.

The most striking feature: No Japanese 10FMNC firm has more than two percent U.S. origin patents; two have none at all. Furthermore, yearly data over the 12 year period show not the slightest trend toward increased U.S. origin patenting by the Japanese. There are a variety of possible explanations for the difference in U.S. origin patenting by the European and Japanese firms. Further analysis is necessary to determine whether the low level of U.S. origin patenting by Japanese firms is due to a conscious policy decision (e.g., assignment of all subsidiaries' patents to the parent company) or if it reflects a difference in the number of U.S. based subsidiaries performing R&D.

Technology Trends

What are the new technology interests of these leading FMNCs? This information may be gleaned from consideration of the PTO classifications (classes and subclasses) to which 10FMNC patents are assigned. For this analysis, the patent activity of the 10FMNCs is examined in 37 of the approximately 370 U.S. patent classes. The focus is on patent classes in which the 10FMNCs are most active* with special emphasis on the "up and coming" Japanese firms. Finer resolution into the subclass level of the PTO classification system, which contains more than 108,000 subclasses, is certainly possible, but prevented here by constraints of time and space. Many other "cuts" at the data are also possible, some of which can be derived from tables in Appendix A1.

Figure 2-5 presents the patent activities of 10FMNCs for each of the 33 patent classes in which the firms collectively are most active. Some classes, which form "families" are grouped together and described generically, e.g., organic chemistry. Patent class totals are presented as bars divided into Japanese and European portions. Contrasts are striking. For example, in the electrical, photography, and computer related classes, the five Japanese corporations often hold a majority of the 10FMNC patents. On the other hand, in the purely chemical and drug related classes, the five Japanese FMNC are barely active.

---

*"Most active" was determined by selecting only those classes in which the 10FMNCs collectively had equal to or more than 1.0 percent of all their patents.

FIGURE 2-5
JAPANESE FMNC vs. EUROPEAN FMNC
PATENTING IN SELECTED TECHNOLOGIES (1969-1980)

Patent Class Description & Number	# Patents (1969 – 1980)	
	Japanese	European
Organic chemistry (260, 525, 528, 544, 546, 548)	192	6519
Drug, bio-affecting & body treating compositions (424)	2	1753
Electrical transmission systems; solid state devices, e.g., transistors (307, 357)	762	718
Electric lamp & discharge devices & systems (313, 315)	594	818
Television (358)	636	362
Radiant energy (250)	264	645
Compositions (252)	253	458
Dynamic magnetic information storage & retrieval (360)	529	150
Bleaching & dyeing of textiles & fibers (8)	2	622
Telephony (179)	309	262
Metal working (29)	214	326
Photography (354)	175	354
Stock material & miscellaneous articles (428)	185	312
Electrical & wave energy chemistry (204)	140	355
Electrical communications (340)	256	235
Metal treatment (148)	219	225
Coating processes (427)	152	266
Optics, systems & elements (350)	175	240
Computers & data processing systems (364)	217	193
Adhesive bonding & miscellaneous chemical manufacture (156)	114	275
Electric heating (219)	186	187
Electricity, motive power systems (318)	202	159

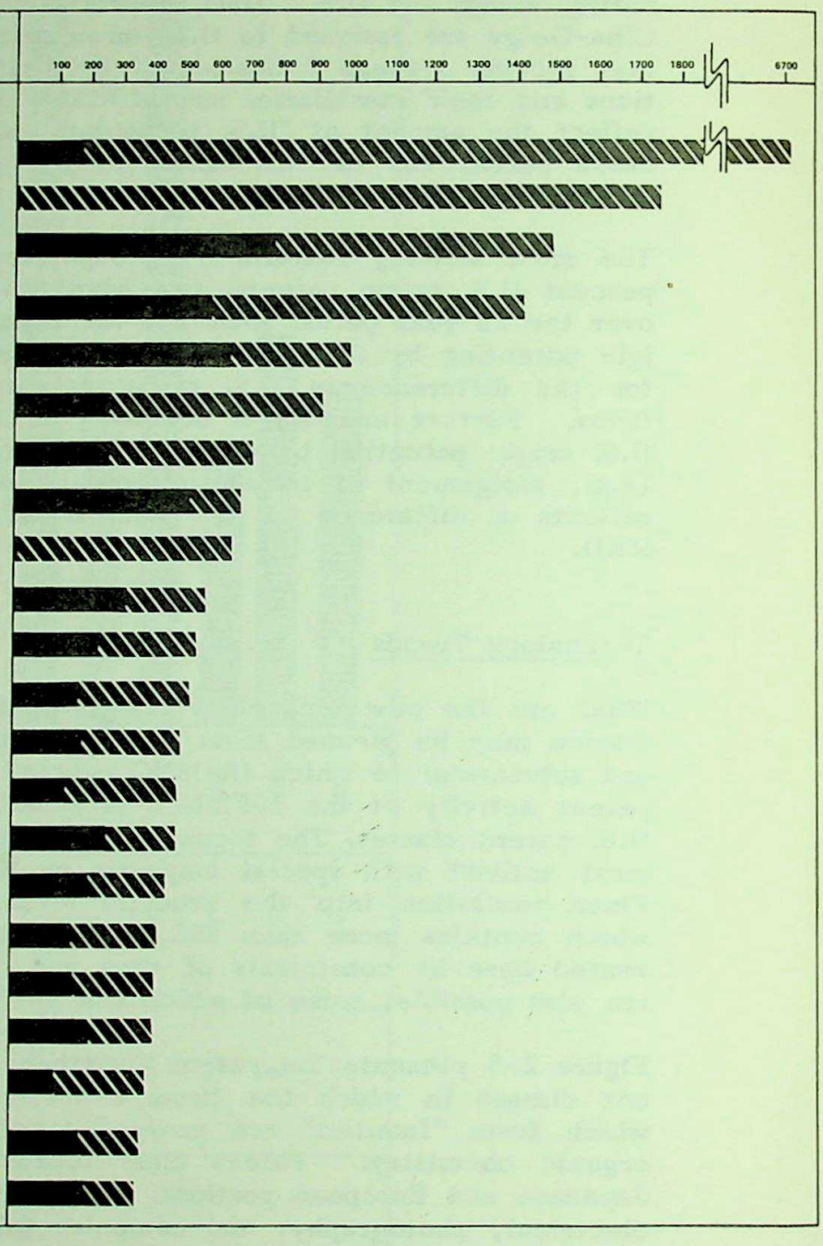


Table 2-2, on the following page, focuses upon the collective patenting of the five Japanese firms. The 29 classes in which these firms are "most active" are selected, and the average percent growth of patenting by these firms is shown for each class. The percent growth is defined as the number of patents granted in the three-year period (1978-1980) divided by the number of patents granted in the six-year period (1975-1980) multiplied by 100 to obtain a percentage. The average percent growth, based on all patents in all classes, is about 46 percent. For comparison, Table 2-2 shows the average percent growth, based on all patents in the selected class, as well as the difference between the Japanese growth and that average.

As might be expected, the five Japanese corporations, four of which are primarily electronics and appliance manufacturers, show highest growth percentages in areas related to that industry. Furthermore, many of the other "active classes" listed are in electrical areas of technology. Although the Japanese firms shows percent growth rates lower than class average in eleven cases, it should be kept in mind that seven of these classes have growth rates above the all-technology average.

However interesting Figure 2-5 and Table 2-2 may be, the data must be kept in perspective. The two universes of firms and classes are quite limited. In addition, a U.S. patent class is, for many purposes, a highly aggregated level of technology. Obviously, corresponding data for a larger universe of firms would be of greater interest and value. For instance, how might the Japanese percent growth in the various patent classes change if all the country's MNCs were included? What would be revealed if Figure 2-5 presented the patenting patterns of, say, all the FORTUNE "Foreign 500"? Also of great interest is more detailed technological information for individual firms.

* * *

In future reports, OTAF intends to (1) expand the universe of FMNCs, (2) examine the patenting patterns of U.S. multinational corporations, and (3) include in its analysis multinational corporation patenting in countries other than the U.S. It is hoped that such data will provide the means to measure more accurately the extent and origins of foreign controlled technology in the U.S. and abroad, as well as provide insight into the activity patterns, trends and dominance of U.S. multinational corporations in the international technology marketplace.

TABLE 2-2

PERCENT GROWTH OF PATENTING IN SELECTED TECHNOLOGIES

FIVE JAPANESE FMNC vs. THE AVERAGE FOR ALL TECHNOLOGIES

Patent Class Description and Number		Percent Growth[1] Five Japanese	Average[2]	Difference
Computers and data processing systems	(364)	71.6	49.8	21.8
Static information storage and retrieval	(365)	67.6	47.1	20.1
Radiant energy	(250)	61.7	43.2	18.5
Stock material or miscellaneous articles	(428)	56.7	49.9	6.8
Metal working	(29)	56.3	46.8	9.5
Electrical generator or motor structure	(310)	53.7	48.1	5.6
Adhesive bonding & miscellaneous chemical manufacture	(156)	53.0	46.7	6.3
Television	(358)	52.7	53.0	-0.3
Electric heating	(219)	52.2	48.1	4.1
Electrical communications	(340)	52.0	44.5	7.5
Electrical systems and devices	(361)	51.8	46.9	4.9
Coating processes	(427)	51.8	51.1	0.7
Electricity, motive power systems	(318)	51.8	47.8	4.0
Dynamic magnetic information storage and retrieval	(360)	48.0	46.8	1.2
Telephony	(179)	46.4	42.6	3.8
Solid state devices, e.g., transistors	(357)	46.4	47.8	-1.4
Photography	(354)	46.3	52.3	-6.0
Electric lamp and discharge devices, systems	(315)	45.4	44.0	0.9
Telecommunications	(455)	44.4	47.2	-2.8
Oscillators	(331)	43.3	41.8	1.5
Electric lamps and discharge devices	(313)	43.2	37.0	6.2
Photographic chemistry	(430)	43.2	43.1	0.1
Metal treatment	(148)	40.0	43.2	-3.2
Compositions	(252)	39.3	46.9	-7.6
Winding and reeling	(242)	38.8	44.6	-5.8
Electrical and wave energy chemistry	(204)	38.8	49.6	-10.8
Electrical transmission systems	(307)	36.9	41.3	-4.4
Amplifiers	(330)	35.9	44.7	-8.8
Optics, systems and elements	(350)	33.6	46.7	-13.1

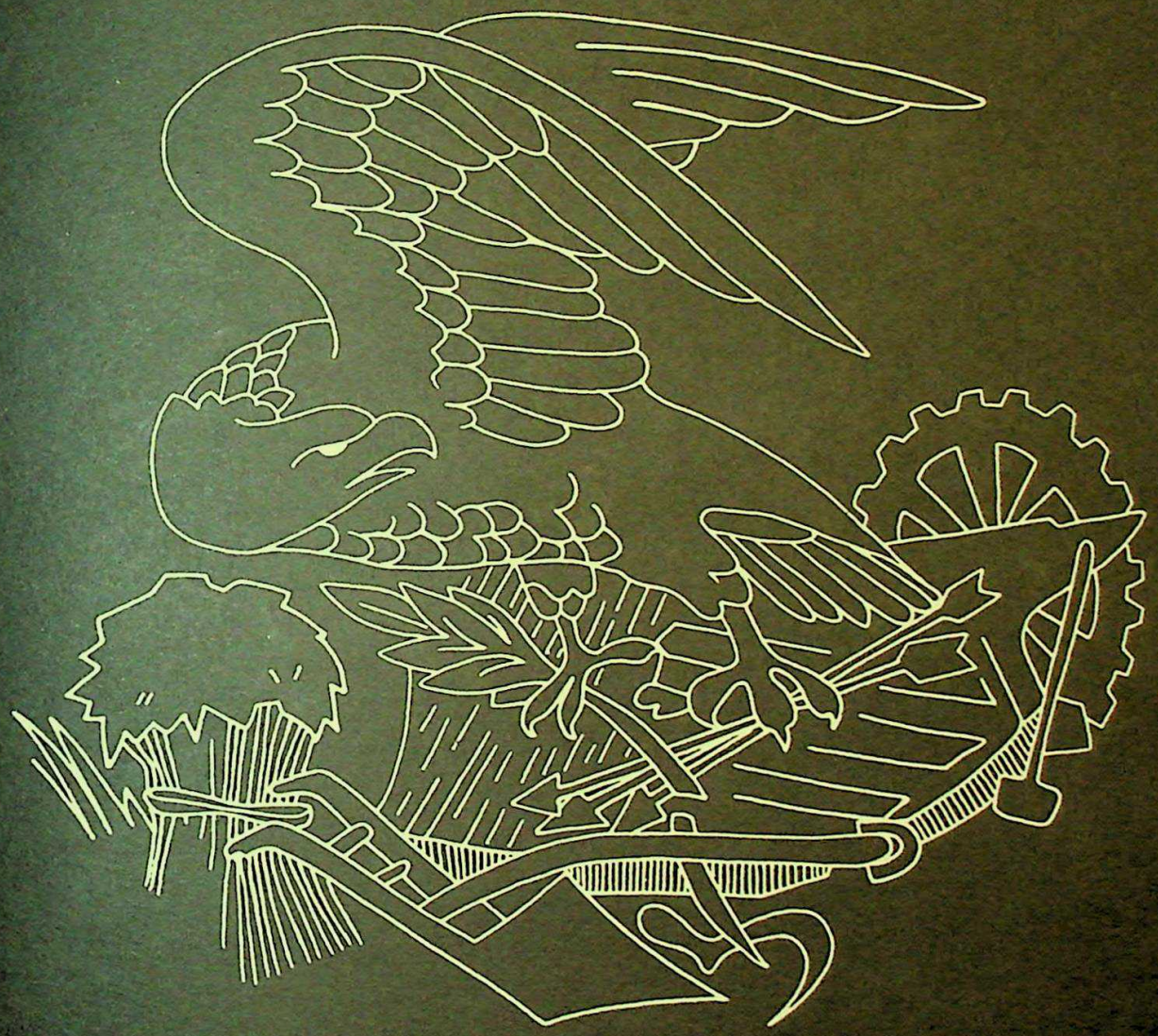
[1]Percent growth is defined on page 45

[2]Average percent growth is calculated from all patents in the class

SECTION - 3

TECHNOLOGY ASSESSMENT & FORECAST

SOFTWARE RELATED TECHNOLOGIES



The Patent System added the fuel of interest to the fire of genius.

A Lincoln

SECTION III - SOFTWARE RELATED TECHNOLOGIES
Patentability: Past To Present

Part I - A Brief History 49

Part II - Recent Supreme Court Decisions 52

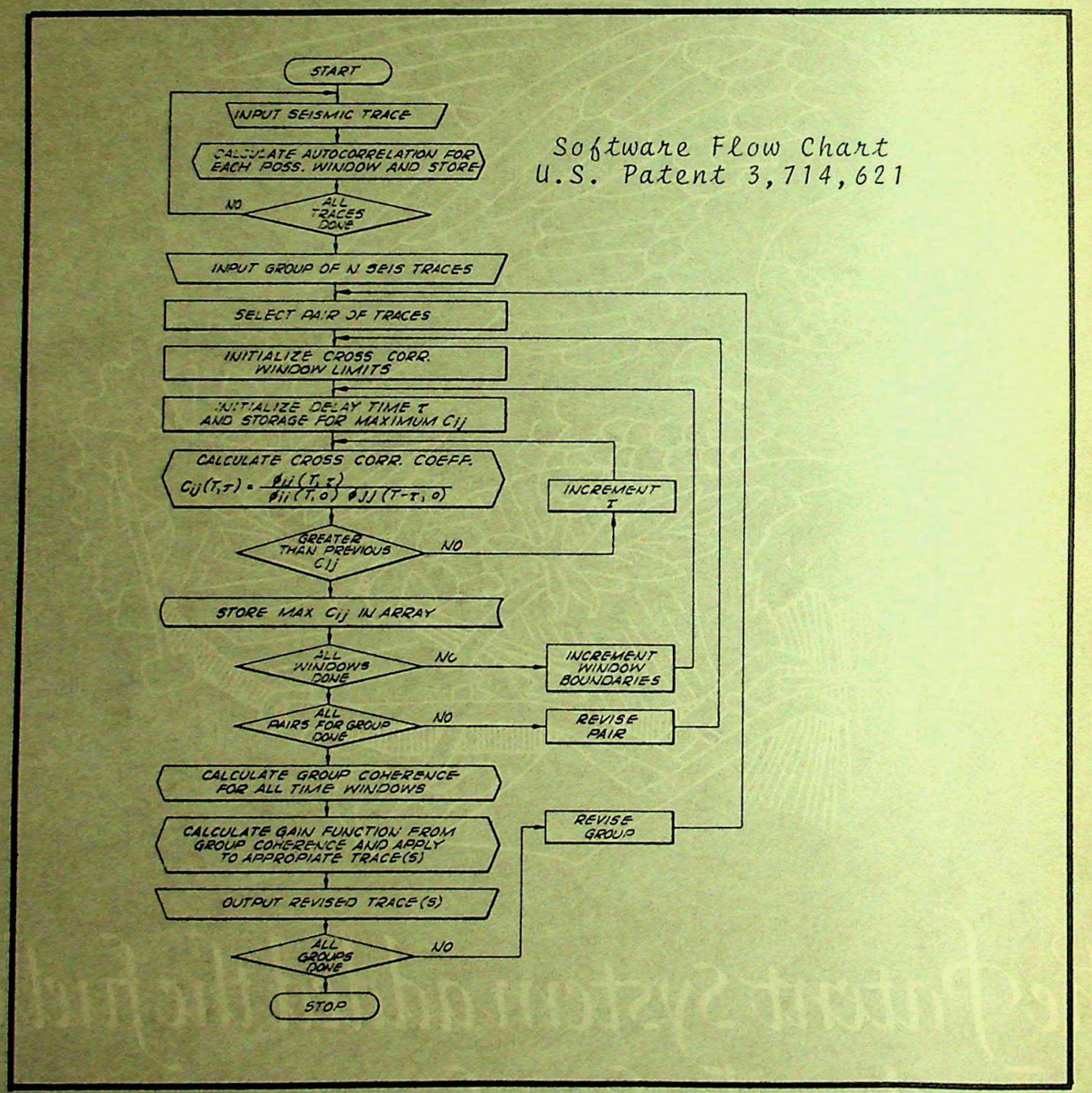
Part III - Patent Activity Analysis 59

Appendix A2

Part 1 - Additional Policy and Legal Decisions 126

Part 2 - Citations and Notes 139

Part 3 - New M.P.E.P. Section 2110 152



Software Flow Chart
U.S. Patent 3,714,621

INTRODUCTION*

With the advent of the recent decisions by the United States Supreme Court in Diamond v. Diehr[1]** and Diamond v. Bradley,[2] over a decade[3] of confusion as to the question of patentability of inventions involving computer software and algorithms may be resolved. The United States Patent and Trademark Office (PTO), in following the spirit of these decisions, has reversed its long standing trend of rejecting most claims drawn to computer program or algorithm related inventions and has drawn guidelines[4] as to which categories of computer program related inventions are patentable.

The purpose of this study is to trace the history and anomalies in the development of the law dealing with the patenting of software and algorithm related inventions; to discuss the present status of the law in this field as a result of the 1981 Bradley and Diehr decisions of the Supreme Court; and to show how these developments have affected patenting in the exemplary field of seismic data processing.

The study is divided into three segments. This, the first segment, covers the legal aspects of the patentability of software related technologies for the period from January through September, 1981 and charts patent activity in seismic data processing for the period from January 1, 1960 through December 31, 1978. The second segment, Appendix A2 - Part 1, is an in-depth review of the metamorphosis of the law in the field for the period of 1964 through 1980, and is directed to those wishing more detailed historical information. The third, Appendix A2 - Part 2, contains citations and notes referred to in the first two segments of this study. Taken together, these three segments constitute a substantially complete record of issues and events affecting the patentability of software related inventions over the last two decades.

PART I -- A BRIEF HISTORY

Mechanical Computers

The first recorded mechanization of computation began with Gerbert of Autilloc and Mangus in the 10th century.[5] In the 16th century, Emperor Rudolfuss II of the Holy Roman Empire granted a patent for a programmed recording pedometer which was used in surveying.[6] In the 17th century mechanical calculators appeared for carrying out addition, subtraction, multiplication and division. In 1649 A.D., Louis XIV granted a patent to Pascal for an arithmetic calculating machine which was programmable for various coinage systems.[7] In 1709, Poleni developed the first calculator which provided a series of answers.[8] In 1804, weaving looms were automated by Jacquard by using punched tapes or cards. From 1833 through 1835, Charles Babbage designed two general purpose digital computers pro-

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*This report was authored by Nelson Moskowitz, a Senior Primary Examiner, Special Laws Division, Examining Group 220. The statements and opinions in this paper are those of the author and do not necessarily reflect the position or views of the Patent and Trademark Office.

**Numbered references may be found in Appendix A2-Part 2.

grammed by punch cards, one a "difference engine" and one an "analytical engine."[9]

Electromechanical Computers

The first electromechanical computers were developed shortly after World War II by Stiblitz of Bell Laboratories and Aiken of Harvard University with the support of IBM and the Office of Naval Research.[10] Aiken's computer utilized the principles of Babbage's general purpose digital computer, but employed electrical circuitry in place of mechanical elements.

Electronic Computers

The first general purpose, all electronic digital computer, the ENIAC,[11] was built with vacuum tubes at the University of Pennsylvania in 1946.[12] Over the following ten years vacuum tube computers were built using storage devices such as electrostatic memories,[13] delay line memories,[14] and magnetic drum memories.[15] The early computers were externally programmed using wired control boards,[16] which had to be manually rewired for each different operation or machine code.[17] Later models used internal instruction storage as devised by Von Neumann of Princeton University.[18]

In 1951, the Remington Rand Corporation introduced the first commercial computer, the UNIVAC.[19] In 1952, a group of scientists at the Institute for Advanced Study completed MANIAC 1, the first digital computer capable of operating upon stored programs, as opposed to hard wired circuitry.[20]* In 1953, IBM introduced the Model 650, a vacuum tube computer using a magnetic drum. The first commercial solid state computer was introduced by IBM in 1959 as the model 7090. This computer quickly rendered tube computers obsolete.[21]

Software and Algorithms

Computer operations are controlled by computer programs -- sets of instructions for controlling the computer.[22] Programs may be in visible format or stored in machine-readable form on punch cards, magnetic tape or disc, or in a computer memory. Programs may be categorized as systems programs and applications programs. Systems programs are directed to the general operation of the computer and control the allocation of machine resources in order to facilitate the running of applications programs. Applications programs are what the ultimate computer users employ in order to perform specific functions for particular applications.

Programs are part of what the industry calls software. Software includes programs, data, routines, back up documentation, flow charts and instruction manuals. The physical components of a computer are called hardware. A computer operating in accordance with a program carries out an algor-

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* Digital computers having circuits physically pre-wired to each other in a particular manner are generally referred to as special purpose digital computers. These computers perform a limited number of special operations. If the circuits are associated only by a program in the computer, the computer is referred to as general purpose digital computer.

ithm[23] which may generally be defined as step-by-step procedure for solving a problem in a finite number of steps.

Algorithms for performing the operations of addition, subtraction, multiplication and division date back to before 3000 B.C. when the abacus was developed.[24] In modern computer software, algorithms are typically set forth as flow charts, stylized diagrams setting forth the steps of the algorithm and their interrelationships. Flowcharts are then used for expressing the algorithm in a manner (language*) that the computer can understand and which directs the hardware in its operation.

In the operation of the computer, a user reads in the data and the programmed set of operations to be performed on the data. The instructions and data are then stored in the computer memory unit. A control unit interprets the instructions and directs the central processing unit (CPU) to perform the designated operations on the inputted data. The CPU then channels the answers to an output unit which supplies the answer to the user.

Patentability of Software

Developing computer software requires an investment of time, money and ingenuity. However, once developed such software can be relatively easily copied. Software manufacturers, in order to protect their interests in the software, have filed patent applications for their inventions. The grant of a patent would provide the inventor, his heirs or assignees the right to exclude others from making, using and selling the patented software for a period of 17 years. The United States Constitution delegates to Congress the power "to promote the Progress of Science and the useful Arts by securing for limited times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries ...."[25] Under this authority, Congress enacted the Patent Laws (35USC). The first requirement of this act limits the subject matter of a patent to a "process, machine, manufacture, or composition of matter, or any new or useful improvement thereof," 35 USC 101 (1979).[26]** The second requires the claimed invention to pass four separate conditions of patentability, utility,[27] novelty,[28] nonobviousness,[29] and adequacy of disclosure.[30]

It is well-settled in the patent law that ideas,[31] scientific principles[32] and laws of nature[33] are not patentable. A process consisting solely of mental steps is unpatentable since it would create a monopoly of a disembodied idea. A novel process, however, is not unpatentable because it incorpor-

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* Commonly used computer languages are FORTRAN (FORmula TRANslation) which is a mathematical problem oriented code, BASIC (Beginners All purpose Symbolic Instruction Code), ALGOL (ALGOrithmic Language) and COBOL (COmmon Business Oriented Language).

**"The term 'process' means process, art or method and includes a new use of a known process, machine, manufacture, composition of matter, or material." 35 USC 100 (b). The term "process" has been further defined by the United States Supreme Court as a series of actions upon certain materials that transforms its subject matter from one state to another state or thing. Cochrane v. Deener, 94 U.S. 780 (1876).

ates laws of nature.

Whether software related inventions represent processes that are patentable or ideas that are unpatentable has been in issue before the Court of Customs and Patent Appeals (CCPA) and the Supreme Court for almost a decade. Several recent Supreme Court decisions may form the legal rationale for finally resolving this issue.

PART II -- RECENT SUPREME COURT DECISIONS

Bradley et al

On April 21, 1975 John S. Bradley and Benjamin S. Franklin applied for a patent on an invention for firmware* which directs the transfer of data within a computer.[34] The computer's hardware includes a main memory which has a system base[35] with which the computer programmer can communicate. In high performance computers, where speed of operation is important, certain information that is part of the system base may be stored in storage components commonly called "scratchpad registers." Because these registers are not, however, normally accessible to the programmer by means of computer programs, changing the data they contain had been a problem.[36]

Bradley et al (Bradley) claimed an invention which provided an improved method for changing the data in the registers. In addition to certain hardware elements, it employed firmware instructions. When activated by software, the instructions cause a particular sequence of computer operations to take place.[37] An instruction in the firmware developed by Bradley permitted the programmer to communicate with the scratchpad registers and to switch data back and forth from the registers to the system base in the main memory.[38]

The Patent Examiner rejected the claimed invention as drawn to nonstatutory subject matter under 35 USC 101. He noted that the hardware arrangement to which the claims referred -- "a main memory, central processing unit, and scratchpad registers" -- were "well-known components" that were "admittedly old in the art." The examiner found that the only novel aspect of the invention resided in an algorithm designed to control the multiprogramming computer to solve the particular problem indicated. He concluded that this "program implemented algorithm" was not patentable under 35 USC 101.[39]

The Patent and Trademark Office Board of Appeals agreed with the Examiner. It found that save for the microprogramming, Bradley's arrangement

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* Firmware has been defined as microprograms (programs which determine how a computer interprets an instruction in machine language) resident in the computers control memory. Opler, Fourth Generation Software, Datamation, Volume 13, January 1967, at page 22. The term is generally used more broadly to define microprograms for multifarious uses so long as the physical mode of the program causes a particular sequence of computer operations to take place.

of hardware was old in the art. It ruled that the fact that Bradley's claims were in "apparatus," rather than "method," format did not make them any less "related to an algorithm." The Board added "a claim for an improved method of calculation, even when tied to a specific end use, is unpatentable."

The CCPA[40] unanimously reversed the Board observing that Bradley was claiming a machine or apparatus composed of a combination of hardware elements which fell "literally within the boundaries of 101." The court recognized that this combination also involves a portion of the computer's control store microprogrammed in a particular manner, and left standing the Board's determination that the apparatus was old in the art and that only the microprogram was new. But it rejected the Board's "distillation of the claim down to the information contained in the firmware."

The proper analysis, said the court, involves determining whether the claimed invention preempts the use of an algorithm. Applying this test, it stated that there was no mathematical algorithm here. Although certain calculations were made, they did not "transform the invention as a whole into a method of calculation" because, after the invention's task was completed, there was no solution of an equation.

In essence the court found the invention to lie in the combination of tangible hardware elements and not in the information embodied in these elements. The court then applied its two-pronged test first formulated in Freeman.[41] First, the claims were reviewed to determine whether they directly or indirectly recited process steps which were themselves calculations, formula or equations; secondly, the claims taken in their entirety were analyzed to see if they wholly preempted these calculations, formula or equations. Using this test the court found that (1) no mathematical algorithm was present, and (2) the invention as whole was not a method of calculation.

The PTO then petitioned the Supreme Court for certiorari.[42] The reasons set forth included the efficient administration of the patent system, and the CCPA's unwillingness to apply the analysis of the claims required by Supreme Court under Flook* namely, testing for patentability by considering whether the complete process, as claimed, is new and useful, while regarding algorithms in the claims as prior art. An equally divided[43] Supreme Court affirmed the CCPA's decision, but made no statements as to their reasons or the merits of the arguments presented.

Diehr

The invention in Diehr is directed to a process using a computer for regulating the curing time of raw rubber in a mold press. Rubber products produced from a mold press are cured under heat and pressure in the press for a specified time. The time needed to obtain a good cure depends in part on the temperature inside the press, which is regulated by a thermostat.[44] It is possible, using well-known time, temperature, and cure relationships, to calculate when to open the press and remove the cured pro-

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*See Appendix A2 - Part 1, page 134 for an analysis of Flook.

duct. Nonetheless, uncontrolled variables present in the actual curing process such as heat loss during loading of the press make it difficult to calculate exact temperature. For this reason, industry practice is to calculate the cure time as the shortest time in which all parts of the product definitely will be cured, assuming a "reasonable amount of mold-opening time" during loading and unloading. The disadvantages of this practice are that erring on the side of caution will usually lead to overcuring the rubber, while keeping the mold open for more than a "reasonable" time will often result in undercuring.

Diehr's claimed invention employs a digital computer to overcome these drawbacks.[45] Measurements of the temperature in the closed, heated press are made at frequent intervals. These measurements are automatically fed into the computer. For each new measurement, the computer recalculated the cure time. When the recalculated cure time equals the actual time that has elapsed since the press was closed, the computer signals a device to open the press.

The Patent Examiner rejected the claimed invention on the sole ground that the claims were drawn to nonstatutory subject matter under 35 USC 101. He determined that those steps in Diehr's claims that are "carried out by computer under control of a stored program" are nonstatutory under the Supreme Court's decision in Benson* which held innovations in the technology of processing data in digital computers to be unpatentable. The remaining steps -- which relate generally to the method of manufacturing precision molded articles, such as the opening, closing, and heating of the mold -- the Examiner found to be "conventional." The Examiner concluded that the claims defined and sought protection of a computer program for operating a rubber molding press.

The Patent and Trademark Office Board of Appeals agreed with the Examiner and unanimously affirmed the rejection. Analyzing the claims, the Board found much that was either within the prior art, such as the constant measurement of the mold temperature, or that involved post-solution activity, such as the automatic opening of the press. The "calculation" recited in the claims, observed the Board, showed that Diehr's system employed an algorithm. The Board summarized: "The only difference between the conventional methods of operating a molding press and that claimed...rests in those steps...which relate to the calculation incident to the solution of the mathematical problem or formula." The Board concluded that this calculation, Diehr's "contribution," was a "computer program of the character" that is nonstatutory.

The CCPA reversed the Board of Appeals.[46] It agreed with the Board that Diehr had "disclosed a computer program," but it stated that this "does nothing to aid in the determination of compliance with 101" and is not "of any significance." It held that the Supreme Court's decision in Flook (i.e., where a claim recites an algorithm such algorithm is to be considered as part of the prior art) was merely a convenient vehicle for finding the method of calculation there to be nonstatutory, and did not establish a general test in determining compliance with 35 USC 101. Thus it refused

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*See Appendix A2 - Part 1, page 131 for an analysis of Benson.

to identify and set aside, as had the Board, those steps in the claim that were old in the art, stressing that, "considerations of novelty and obviousness have no bearing on compliance with 101." The CCPA instead considered the "claims, as a whole" and found that they recite a process or method for molding rubber articles at whose "heart" is a molding press, not an equation or method of calculation. Since this process constituted an improvement over prior processes, themselves patentable subject matter, the court concluded that Diehr's process was likewise patentable.

For substantially the same reasons set forth in its petition for certiorari in Bradley, the PTO petitioned the Supreme Court for review in Diehr.[47]

The Supreme Court published its opinion in Diehr almost one week prior to its decision in Bradley. In Diehr, by a 5-4 decision, with Justice Rehnquist writing for the majority, the Supreme Court affirmed the CCPA's decision and found the claimed invention to be directed to a statutory category of invention. The Court began its decision noting its portentious decision of the Court's previous term in Diamond v. Chakrabarty,[48] where it (1) held that an invention directed to a man-made bacterium for breaking down crude oil was within the statutory categories of invention set forth in 35 USC 101, and (2) rejected the PTO argument that living things were excluded from patent protection under 35 USC 101 until Congress expressly authorizes their patentability.

As in Chakrabarty, the Court in its analysis of 35 USC 101 cautioned, "courts should not read into the patent laws limitations and conditions which a legislature has not expressed." Considering the category of invention of "process" the Court equated this term with the term "art," a category of invention in the Patent Act of 1793[49], and noted that the analysis of the eligibility of a patent claim for a process did not change with the exchange of that term for the term "art" in 35 USC 101. As exemplary of legislative opinion as to what patentable subject matter includes, the Court cited the Congressional Committee Reports[50] which accompanied the 1952 patent act as indicative that Congress intended statutory subject matter to "include anything under the sun that is made by man." (Emphasis added.)

Diehr's claimed invention was found to be directed to the transformation of an article, raw uncured synthetic rubber, into a different state or thing. The Court thus differentiated Diehr's invention from that of Benson and Flook. In contrast to Diehr, the sole practical application of the mathematical algorithm in Benson was in connection with the programming of a general purpose digital computer. Such an algorithm was considered like a law of nature and not subject to patent protection. Flook's invention was found to be directed to computing an alarm limit (a number). The claims directed thereto sought to protect the formula for computing that number. Diehr, on the other hand, was found not to be generally preempting the mathematical equation employed in his process except in conjunction with all the other steps of his claimed process.

It was the basic position of the PTO that the claim should be dissected under a point of novelty approach and the algorithm be considered as part of the prior art. The Court emphatically stated that the claims must be

considered "as a whole." The analysis suggested by the Office, noted the Court, would undermine earlier decisions regarding the criteria to consider in determining eligibility of a process for patent protection. Furthermore, contrary to its indication in Flook, the Court here found that considerations of novelty under 35 USC 102 are "fully apart from whether the invention falls into a category of statutory subject matter."

As for post-solution activity, the Court ruled that "insignificant post-solution activity" will not transform an unpatentable principle into a patentable process. Citing Flook in this regard the Court stated:

> A mathematical formula does not suddenly become patentable subject matter simply by having the applicant acquiesce to limiting the reach of the patent for the formula to a particular technological use. A mathematical formula in the abstract is nonstatutory subject matter regardless of whether the patent is intended to cover all uses of the formula or only limited uses. Similarly, a mathematical formula does not become patentable subject matter merely by including in the claim for the formula token post-solution activity such as the type claimed in Flook.

The dissenting four Justices began their opinion with a review of the history of computers and computer related patent law. The crux of this review lay in a critical analysis and summation of the CCPA decisions beginning with In re Tarczy-Hornoch[51] and ending with In re Diehr.[52] The dissent found the CCPA's approach to 35 USC 101 throughout the 12 year duration between these cases to be "expansive," and the CCPA's post-Flook decisions to "trivialize" the Court's holding in Flook, the principle that underlies Benson, and the settled line of authorities reviewed in those opinions.

Considering the broader question of whether computer programs, per se, should be given patent protection, the dissent reiterated the Court's previous position in Benson and Flook that due to the complex policy considerations involved, which the Court is not authorized to address, the decision should be made in its appropriate forum, i.e., Congress.

PTO Practice after Bradley and Diehr

By mid-March, 1981, less than one month after the Supreme Court decisions, a committee had been formed by the PTO to draft new guideline proposals for patent examination in software related cases.[53] Meanwhile, the Patent and Trademark Office Board of Appeals reviewed apposite cases then under appeal in light of the Supreme Court decisions in Bradley and Diehr. By September 30, 1981, at least seventeen applications were reviewed and decisions rendered. These decisions by the Board indicate a change in policy, by at least a majority of the Board members, favorable toward the patenting of software related inventions. Of the seventeen appeals decided by the Board, nine were reversals of the Examiner's

position while eight affirmed the Examiner. This ratio of reversals to affirmances was substantially higher than prior to the Supreme Court's decision in Bradley and Diehr.

In the majority of appealed applications reviewed by the Board, the two part test of Freeman as modified by the CCPA in Walter[54] was applied. The claims were first analyzed to determine if they recited nonstatutory mathematical algorithms as defined in Benson. Claimed inventions not containing such algorithms were found to be within the statutory categories of invention. If found to recite mathematical algorithms, the claims were then considered as a whole to determine if the algorithm transformed at least one element of the invention to a different state or thing. If such a transformation took place, the claims were considered to be within the statutory categories of invention.

Inventions directed to processes for modeling physical events or elements and which are claimed as performing mathematical operations have been found unpatentable by the Board. The Board particularly pointed out that operations on synthetic (hypothetical) signals, which results have no necessary relationship to actual signals which might be derived from actual measurements, are nonstatutory subject matter.

Inventions directed to deriving values of physical parameters of an entity by mathematically processing data obtained by actual measurements have been found unpatentable by the Board. The Board considered the derivation to be a simulation of something physical by a process akin to mathematical modeling and in line with the CCPA's pre-Diehr decision in Walter. However, inventions directed to filtering of data by mathematical algorithm processing were found patentable in view of the CCPA's ruling in Johnson, and inventions directed to determining the direction and identity of targets emitting radiation were found patentable as the end product was not a pure number.

In considering whether a "physical conversion" had taken place, the Board looked to both the environment and the post-solution activity of the claimed invention. Secondary factors, such as the recitation of necessary antecedent steps which establish or provide values for variables in a mathematical algorithm, were found not to convert an otherwise nonstatutory method to one that is statutory. In one Board opinion, the majority of the Board opined that a numerical end product of an algorithm can be considered "a physical thing" where it indicates physical aspects of an entity.

Similarly, limiting the claimed invention to a particular art or technology and/or claiming merely the recording of the output of the mathematical algorithm were found not to render otherwise nonstatutory subject matter to a statutory category of invention.

In one of the two dissenting opinions of the seventeen Board decisions reviewed, one Board member admonished the Board to be cautious in applying precedents of the CCPA which were decided before Diehr. In this Board member's view, Diehr should be taken as the last word, "the new testament," of the Supreme Court and all reasoning should stem directly from that opinion until the CCPA has an opportunity to interpret it on a case-by-case basis.

This dissenting Board member reversed his pre-Diehr Board decision which had affirmed the Examiner's rejection of the claimed invention under 35 USC 101 as directed to a nonstatutory category of invention. Analyzing the claimed invention as to whether patent protection was being sought for an algorithm in the abstract, he found that the appellant was not seeking a patent merely for a mathematical formula. As the environment of the invention was set forth in the claims, the dissenting member argued that citizens who perform the algorithm per se are not infringing on appellant's claims. The opinion concluded with the note that "...Congress intended statutory subject matter to 'include anything under the sun that is made by man'; Diehr, 209 USPQ at page 6, quoting the Committee Reports accompanying the 1952 Act."

Guidelines

Readers should find the following guidelines helpful in drafting or reviewing claims directed to algorithm or other software related inventions.

1) Prospective claims should be first analyzed to see if they "directly or indirectly" recite a mathematical algorithm, be it by mathematical symbology or in prose format. If the claims at issue fail to "directly" recite a mathematical algorithm reference should be made to the specification to determine whether claim language indirectly recites mathematical calculations, formulas, or equations. If no mathematical algorithm is recited in the claims, the first of the dual Freeman tests required by the CCPA has been passed and no further inquiry into this issue is necessary.

2) If the reviewed claim is found to recite a mathematical algorithm, further inquiry should be made as to whether or not the claim is seeking patent protection for a formula in the abstract. For the latter, the claim should be viewed as a whole, without dissection of the claim into old (prior art) and new elements and then ignoring the old elements in the analysis. In order to circumvent the claiming of essentially a mathematical calculation in the abstract, the claim should set forth transformations of articles or physical steps to different states of things and the interrelationship between the algorithm and articles or physical steps. The addition of such physical manipulations or transformations to the claim indicates the algorithm to be part of the overall process or apparatus and not an abstract method of calculating.

3) The recitation of significant environmental background, such as the specific technology and/or use of apparatus of the invention should be recited to narrow the scope of the claims so that they will not preempt the algorithm per se. Setting forth claim limitations directed to the particular type of computer used in processing the algorithm is not sufficient to make the invention patentable. The Board has found that regardless of the type of computer used, i.e., general purpose digital computer, special purpose digital computer, analog computer or pencil and paper, the invention may be unpatentable, as it "...defies logic to urge that a process is directed to a mathematical algorithm when practiced on a general purpose digital computer but is not directed to a mathematical algorithm when practiced on a special purpose digital computer." Since there is substantial question whether words in a preamble which do not appear in the body of a claim may be used to limit the scope of the claim, unambiguous

terminology should be used. For example, in Arshal[55] where the U.S. Court of Claims considered the validity of a software related invention, the term "directional computer" was found to be ambiguous concerning the exact technology, to which that invention was directed.

4) The recitation of pre-solution activity which includes more than just the necessary antecedent steps for obtaining values required for the algorithm can be evidentiary of the algorithm being only a portion of the invention. The addition of old (prior art) and necessary antecedent steps of establishing values for variables in the mathematical algorithm will not convert an unpatentable method or apparatus to patentable subject matter. Even the recitation of data gathering steps which are novel and unobvious, in combination with mathematical computing steps, may be insufficient to give rise to a patentable claim under 35 USC 101. The CCPA decisions in Christensen and Richman, discussed in Appendix A2, are exemplary of this rule. They were directed to, respectively, processing wellbore data to compute substrata porosity and calculating an airborne radar boresight correction angle.

5) Significant post-solution activity, clearly defined in the claim, is a factor indicating the algorithm to be part of a process. Necessary post solution steps, such as displaying output data, are generally not considered significant. For example, updating of alarm limits by transmitting electrical signals representing the results of calculations obtained by an algorithm has been found by the Supreme Court in Flook to be insignificant post solution activity. On the other hand, curing rubber at specific temperatures and times derived using an algorithm has been found by the Supreme Court in Diehr to constitute significant post-solution activity.

6) Drafting claims in an apparatus type format of "means for" (functional) terminology, which claims are otherwise equivalent to process claims, should result in the same analysis being applied to these claims as is applied to the process claims. The fact that these function type claims may be categorized as directed to a machine is irrelevent to considerations under the Freeman test.

The U.S. Court of Claims stated in Arshal "...the line of demarcation between a patentable and an unpatentable (or non-patentable) claim does not always shimmer with clarity." Following the above recommendations can help prevent drafting claims which would preempt the algorithm rather than define an invention which, considered as a whole, is performing a function which the patent laws were designed to protect.

PART III -- PATENT ACTIVITY ANALYSIS

Having explored the present legal status of patentability of software related inventions, we now turn to patenting in a typical software "technology," seismic data processing. Of primary interest is the effect the changing legal status surrounding patentability of this technology has had on patents granted in this area. Also of interest are the actors in the technology, the country/or state from which the patents originate, and the activity trends in this technology.

Due to the difficulty of obtaining patents for inventions in certain areas

of data processing, one would expect that many developments in methods of seismic data processing were not patented. Furthermore, the propensity to patent in this area should be affected by the changing judicial opinion over the 1960-1978 time period. Favorable judicial opinions should encourage filings whereas unfavorable opinions would have the opposing effect.

In the analysis which follows, the characteristics and trends in seismic data processing are identified. Also examined is the impact of conflicting court decisions and questionable patentability on the number of patent applications filed.

A previous OTAF publication reported on patent activity trends in all of seismic data processing.* This report focuses only on seismic data processing patents where software related technology is an issue.

Subject Area

Seismic exploration, broadly, can be defined as the analysis of the earth's structure and composition using physical measurements of acoustic or shock waves (hereinafter seismic waves) taken at or near the area to be studied. Generally the area to be studied is hidden from direct view and lies under thousands of feet of soil and rock. Such exploration is used primarily in prospecting for valuable natural resources, including hydrocarbons (oil, gas, coal), minerals and water.

In a typical seismic survey, measurements of reflected or refracted seismic waves are made over the earth's surface, parallel to it, or in a borehole. These measurements contain variations in space, amplitude, and/or time of the seismic waves. The nature of the seismic waves is determined in part, by the nature and structure of the subsurface. Due to their complexity, received seismic waves must be quantitatively processed to help determine the nature of the substrata. This complexity is caused by many factors including the numerous types of seismic waves, the different velocities and paths travelled by the seismic waves, and the variations in their attenuation.

Improvement of the usefulness and quality of received seismic wave data is achieved by a number of processes, some simple, others fairly specialized and sophisticated. Seismic signal processing inventions for which patents were filed prior to 1960 were generally fixed arrangements of circuit components (analog systems) designed to perform the claimed methods. During the 1960's, digital processing techniques were introduced. Due to their generally higher speed, lower expense, and greater versatility, these techniques displaced most analog processing systems. Thus, modern seismic exploration typically uses digital computers to control field operations, facilitate digital recording and handling of data, process the data and provide modes of data display which permit faster and more accurate data interpretation.

This area of technology was selected for a number of reasons. First, it is an area of widespread interest and impact. During 1980 more than three

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*See Eighth Report of the Office of Technology Assessment and Forecast, December 1977, page 85.

billion dollars was spent by the free world for geophysical exploration.* Ninety-four percent of this amount was spent on seismic exploration while the remaining six percent was spent on electromagnetic, magnetic, radiometric and gravitational exploration. Almost one-half of the expenditures for geophysical exploration during 1980 took place in the United States. This represents an increase of forty percent over 1979 spending in the field. Secondly, seismic data processing is basically a U.S. technology, thereby minimizing the problem of data error resulting from omission of foreign technological developments which are not patented in the United States.

Procedure

The first step in the patent analysis was to identify software related patents. This was done by defining the area of seismic data processing in terms of subclasses, the smallest units of the U.S. Patent Classification System. Once this was accomplished, these subclasses were manually searched to identify software related patents. The patent data obtained were cross-checked by comparison to U.S. patents having International Patent Classification designations which relate solely to processing seismic data. Then, the listing of software related patents granted between January 1960 and December 1980 was used to generate standard OTAF profile reports containing the following patent information:

Patent Activity Data - Patent activity was tabulated by application filing date of the patents. Patents distributed by application filing date are referred to in this study as patented applications. For the most part, the analyses utilize these patented application data because the application filing date more accurately reflects when the technology was developed and when the inventor or assignee had the propensity to seek patent rights.

In general, patented application data are presented for the period 1960-1978. Data for 1979-1981 are incomplete because many patent applications filed in these years, which eventually will be patented, are still pending in the Patent and Trademark Office.

Assignment Data - Assigned patents in this technology were extracted and tabulated by assignee and application filing date.

Foreign Activity Data - For each patent the country of origin (if other than the U.S.) as indicated by the residence of the first listed inven-

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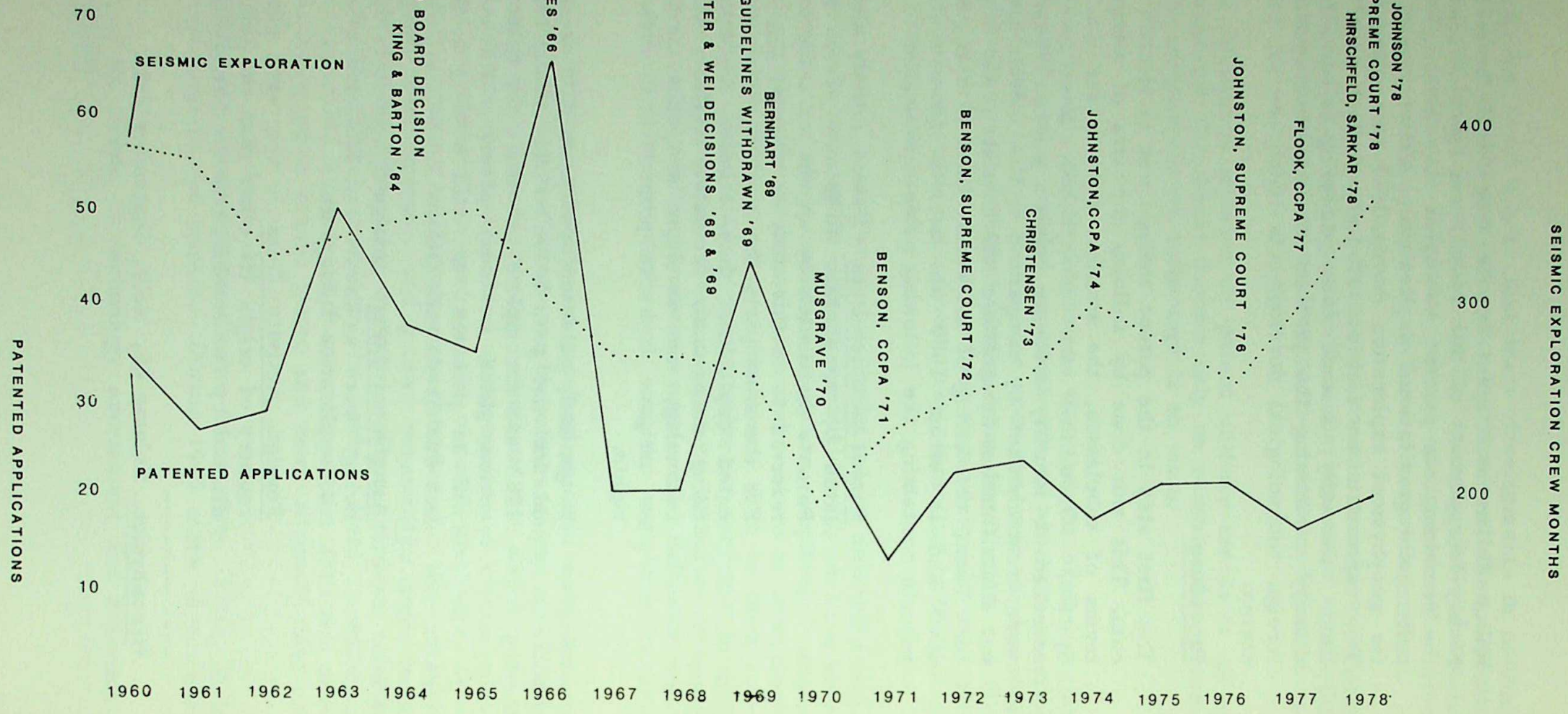
*Geophysics, Volume 46, No.9, September 1981.

FIGURE 3 – 1
COMPARISON OF PATENTED APPLICATION ACTIVITY
IN SEISMIC DATA PROCESSING WITH SEISMIC EXPLORATION ACTIVITY,
JUDICIAL DECISIONS AND POLICY GUIDELINES



tor was recorded. Data were tabulated by year of application filing and are reported as a percentage ("percent foreign") of the total patented applications filed in the area in each year. This information is useful in determining the position in this technology of the United States vis-a-vis foreign countries.

State of the Inventor Data - The state of residence in the United States of the first listed inventors was recorded for all U.S. origin patented applications. The percentage of patents granted to each particular state of the total patents granted was calculated. This information is of interest in determining the level of activity in this technology for particular states.

Trend Analysis

The Fig. 3-1 graph shows the variance in numbers of patented applications (solid line) for each year from 1960 through 1978, the timing of judicial and policy decisions affecting the patentability of software, and the number of seismic crews searching for oil and gas in the U.S.A., by crew months (dotted line). The number of seismic crews prospecting is considered to be a leading indicator of oil and gas exploration activity.* An increase in the number of active seismic prospecting crews engenders an increase in the amount of seismic data obtained. As more data are obtained, the demand for data processing increases. In the face of mounting data processing requirements, better techniques have been developed through innovation in processing of the data. Thus, a correlation might be expected to exist between seismic exploration activity and the number of patented applications filed for inventions in this field.

In the early 1960's, the number of patented applications increased from a low of 28 in 1961 to a high of 65 in 1966, a dramatic increase of 132%. During this period no judicial decision directly related to the issue of software patentability was rendered, permitting inventors normal access to patent protection. Only the PTO Board of Appeals 1964 decision in Ex parte King and Barton[56] obliquely addressed this issue at that time. The rejection in that case was under 35 USC 103 and questioned the obvious nature of the invention. The Board, in its dictum, stated that a computer with a program stored within it is patentably distinct from other computers without such a program.

In 1966, the PTO proposed guidelines[57] which would permit patenting of "utility step" inventions, i.e., inventions which cause a transformation in the state of the computer, but would not permit patents for claims based on computer execution of mathematical formulas. In the two year period

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*Geophysics, Volume 46, No. 3, A-65, March 1981. These figures are compiled from data reported by oil companies operating company owned seismic exploration crews and vessels and by contract seismic exploration companies.

following these proposed guidelines the number of patented applications dropped precipitously from 65 to 20, a decline of 69%.

A portion of this decrease may be attributed to the decline in the number of seismic crew months over this period. In 1966, 300 crew months of exploration took place while in 1968, there were only 270 crew months. This trend of decreasing exploration activity continued until 1970 when it reached a low of 190 crew months of exploration in 1970. From 1970 to 1978 the number of seismic crew months increased to 350. However, as depicted by Figure 3-1, the number of patented applications over this 8 year period has remained fairly steady at approximately 22 patented applications per year.

This lack of increased patent applications in this field after 1969, appears to be more related to the PTO's continued rejection of claimed inventions directed to software related inventions following withdrawal of its 1966 proposed guidelines.

In 1970, the CCPA decision in In re Musgrave allowed claims directed to a method for obtaining better seismograms.[58] The process of Musgrave used a digital computer to obtain weathering layer corrections for seismic data. This decision, for a brief period of over one year, broadened the scope of patentable software related inventions.

The Supreme Court's decision of November 20, 1972 in Benson, reversed the CCPA's allowance of claims directed to a method of converting numerical information from one numerical base into another.[59] Although the Supreme Court specifically stated that its decision did not preclude a patent for any program servicing a computer and did not extend to analog computers, it failed to specify the types of software related inventions which would be patentable. Thus, the decision severely curtailed the prior standards of patentable invention set forth by the CCPA in Musgrave.

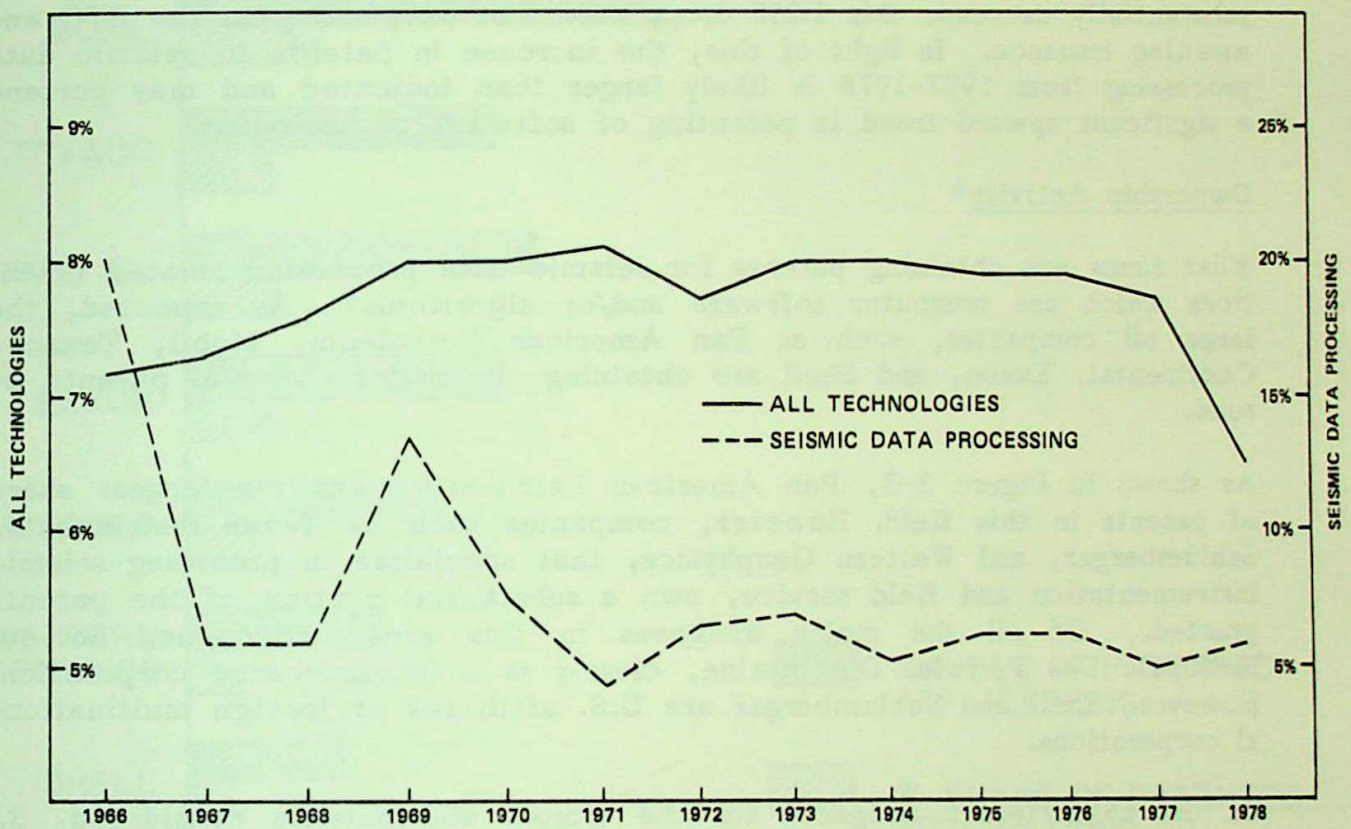
The small drop in patented applications in the 1973-1974 period following the Supreme Court's decision in Benson, when taken in view of the sharply increased seismic crew activity for this period, may be indicative of a large differential in the number of patent applications that normally would have been filed.

From 1973 through 1978, the CCPA sought to set up parameters with which one could judge the patentability of software related inventions. During this period, the PTO appealed four[60] of the CCPA decisions to the Supreme Court. In the two[61] of these four cases which the Supreme Court decided to hear the CCPA was reversed and the claimed inventions found not patentable.

Thus, over the decade from 1968 through 1978, the data indicate that the continuous changes in the metes and bounds of what constitutes a patentable software related process may have discouraged the filing for patents in this area. Although prospecting activity in the area almost doubled over this time period, patenting decreased.

Figure 3-2 shows the yearly percent share* of the total patented applications from 1966 through 1978 for seismic data processing and for all technologies. During this period 329 patented applications were received for seismic data processing and 824,300 patented applications for all technologies.

FIGURE 3-2
YEARLY PERCENT SHARE OF 1966-1978 TOTAL U.S. PATENTED APPLICATIONS:
SEISMIC DATA PROCESSING vs. ALL TECHNOLOGIES



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*"Percent Share" = Patented applications per year divided by the total for the 1966-1978 period times 100. For example, a constant level (same number of patented applications per year) over a 10 year period would result in a straight line graph at the 10% level.

The trends indicated by this graph for seismic data processing are analagous to those in Figure 3-1, except they are presented here as yearly percent share of the 1966-1978 total, as opposed to numbers of patented applications. However, an additional dimension of comparison is presented in observing the fairly level rate of patented applications for all technologies during this time period, while patenting in the seismic data processing area was more erratic. Of the total patented applications filed in the area of seismic data processing, 21% were filed in 1966 to as compared to only 6.1% in 1978. The 1.2% drop in patented applications for all technologies from 1977 to 1978 is partially attributed to the pendency period of applications filed in 1978 and the lower than normal number of patents granted in 1979. A number of such applications, significant enough to substantially decrease this 1.2% drop, may still be pending in the PTO and awaiting issuance. In light of this, the increase in patents to seismic data processing from 1977-1978 is likely larger than indicated and may portend a signficant upward trend in patenting of software technologies.

Ownership Activity*

What firms are obtaining patents for seismic data processing related inventions which use computer software and/or algorithms? As expected, the large oil companies, such as Pan American Petroleum, Mobil, Texaco, Continental, Exxon, and Shell are obtaining the major share of patents issued.

As shown in Figure 3-3, Pan American Petroleum owns the largest share of patents in this field. However, companies such as Texas Instruments, Schlumberger, and Western Geophysics, that specialize in providing seismic instrumentation and field service, own a substantial portion of the patents granted. Of all the major assignees in this area, only one, Societe Nationale Des Petroles D'Aquitaine, clearly is a foreign-based corporation. However, Shell and Schlumberger are U.S. affiliates of foreign multinational corporations.

Of the 65 different assignees for the almost 400 patents considered, 32 owned only one patent each. Thus, approximately one-half the assignees own approximately 92% of the patents in this technology.

Of all patented applications in this field for the three year period of 1976 through 1978, 84% were assigned to corporations. This is only 12% more than the 72% patented applications average for all technologies over this same period. Approximately 8.8% of the patents over the same three year period are assigned to the U.S. or foreign governments. This is almost seven times the all technology average of 1.3% for the same time period.

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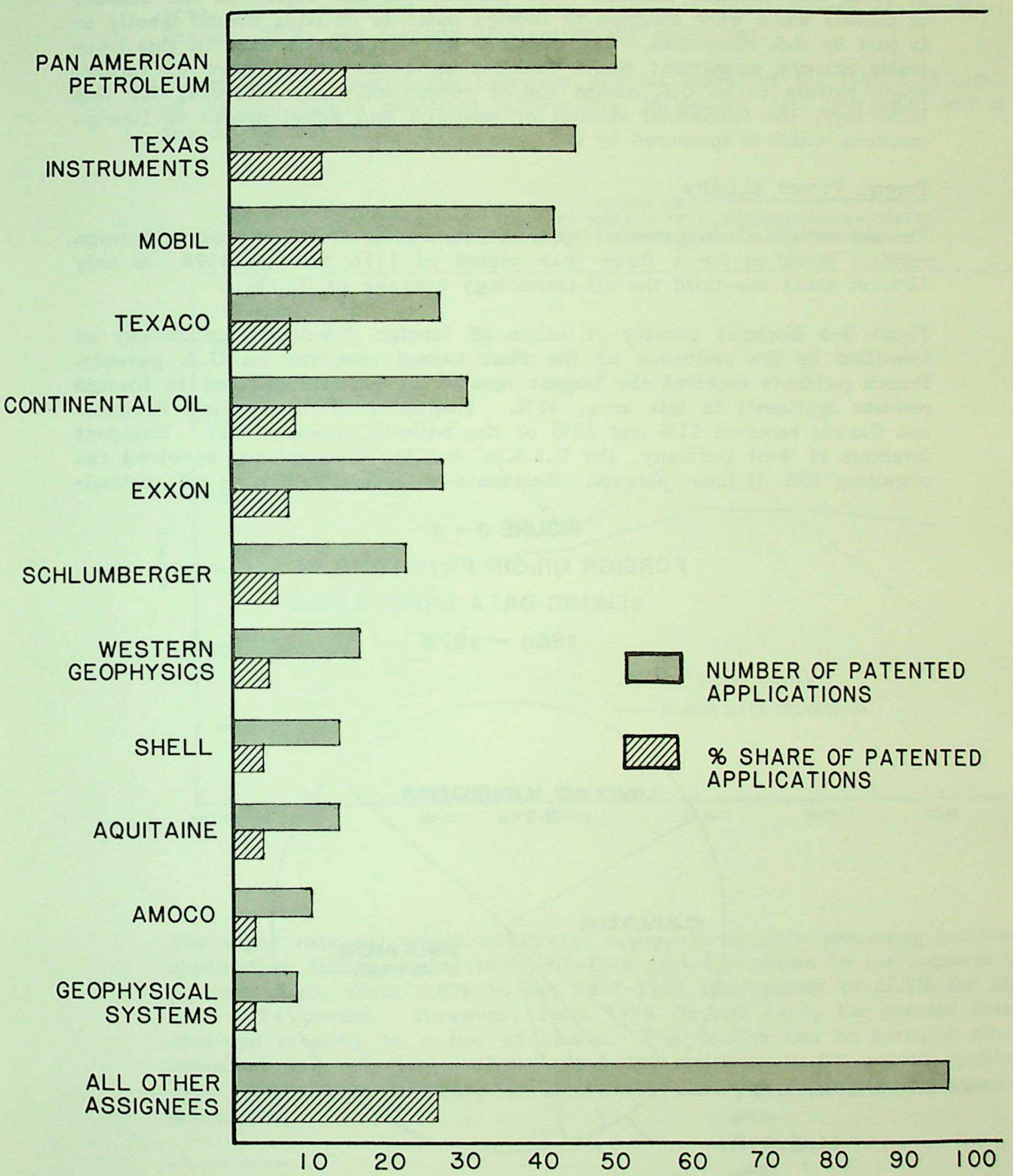
*Patenting for corporations mentioned in this section includes that of subsidiaries, where they could be identified. For example, "Schlumberger" includes patents assigned to: Schlumberger Technology Corporation; Schlumberger Instruments et Systemes; Schlumberger Limited; Schlumberger N.V.; Schlumberger Overseas Messgeratebau Und Vertrieb; Schlumberger Well Surveying Corporation; Schlumberger N. & Cie.

FIGURE 3 – 3
1960 – 1978 CORPORATE PATENTING IN
SEISMIC DATA PROCESSING
NUMBER AND % SHARE OF ASSIGNED PATENTED APPLICATIONS



Ownership of foreign origin inventions by U.S. companies in this area of technology is substantially higher than the overall technology average of 8.7%. Of the patented applications granted to foreign resident inventors during this same three year period, 70% are assigned to U.S. corporations or other U.S. business entities. Not included in this figure is the number of patents which were assigned to foreign business entities owned wholly or in part by U.S. companies. The inclusion of such patent data in this ownership activity assessment would indicate an even larger share of foreign origin patents to be U.S. owned and/or controlled. This reflects, for this technology, the substantial amount of research and development in foreign countries which is sponsored by U.S. companies.

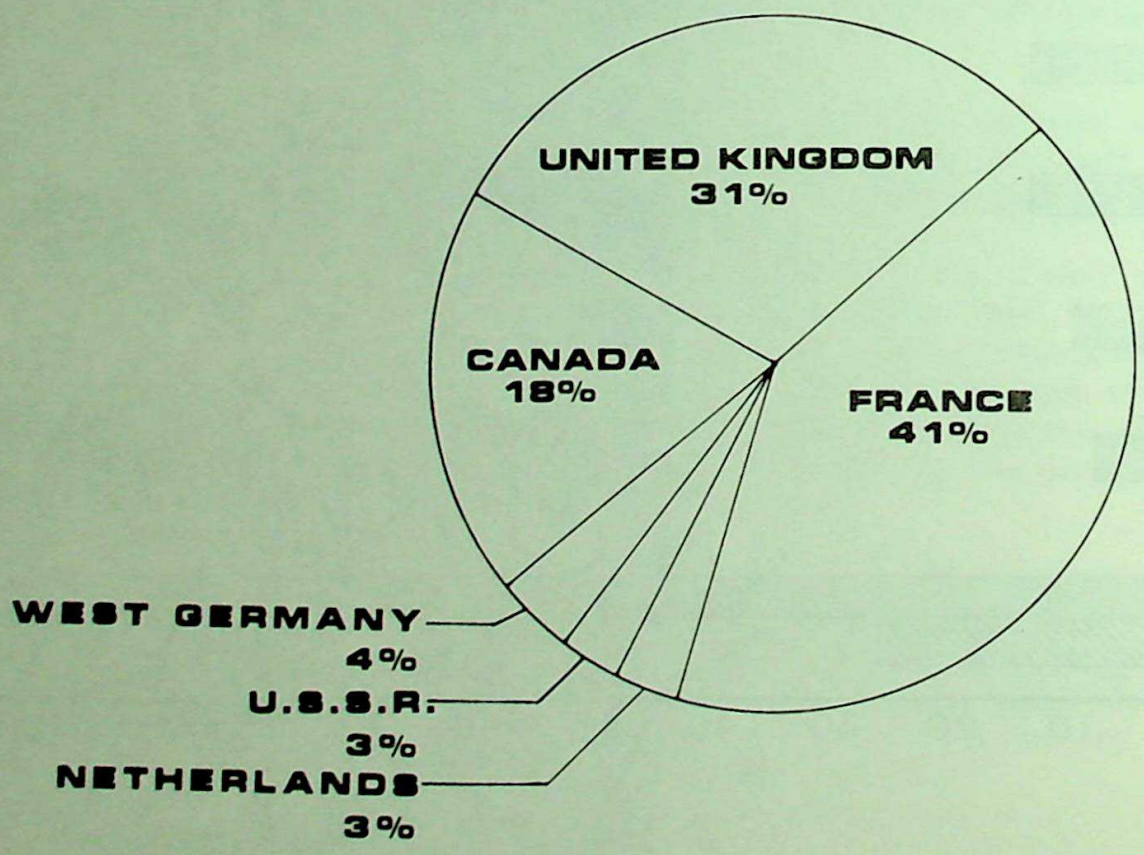
Foreign Patent Activity

The percentage of all patented applications in this field granted to foreign resident inventors for a three year period of 1976 through 1978, is only 12%, or about one-third the all technology average of 37.7%.

Figure 3-4 discloses country of origin of foreign developed technology as identified by the residence of the first named inventor on U.S. patents. French residents received the largest number of patents granted to foreign resident applicants in this area, 41%. Residents of the United Kingdom and Canada received 31% and 18% of the patents, respectively. Resident inventors of West Germany, the U.S.S.R. and the Netherlands received the remaining 10% of these patents. Residents of Japan, which in all technol-

FIGURE 3 - 4

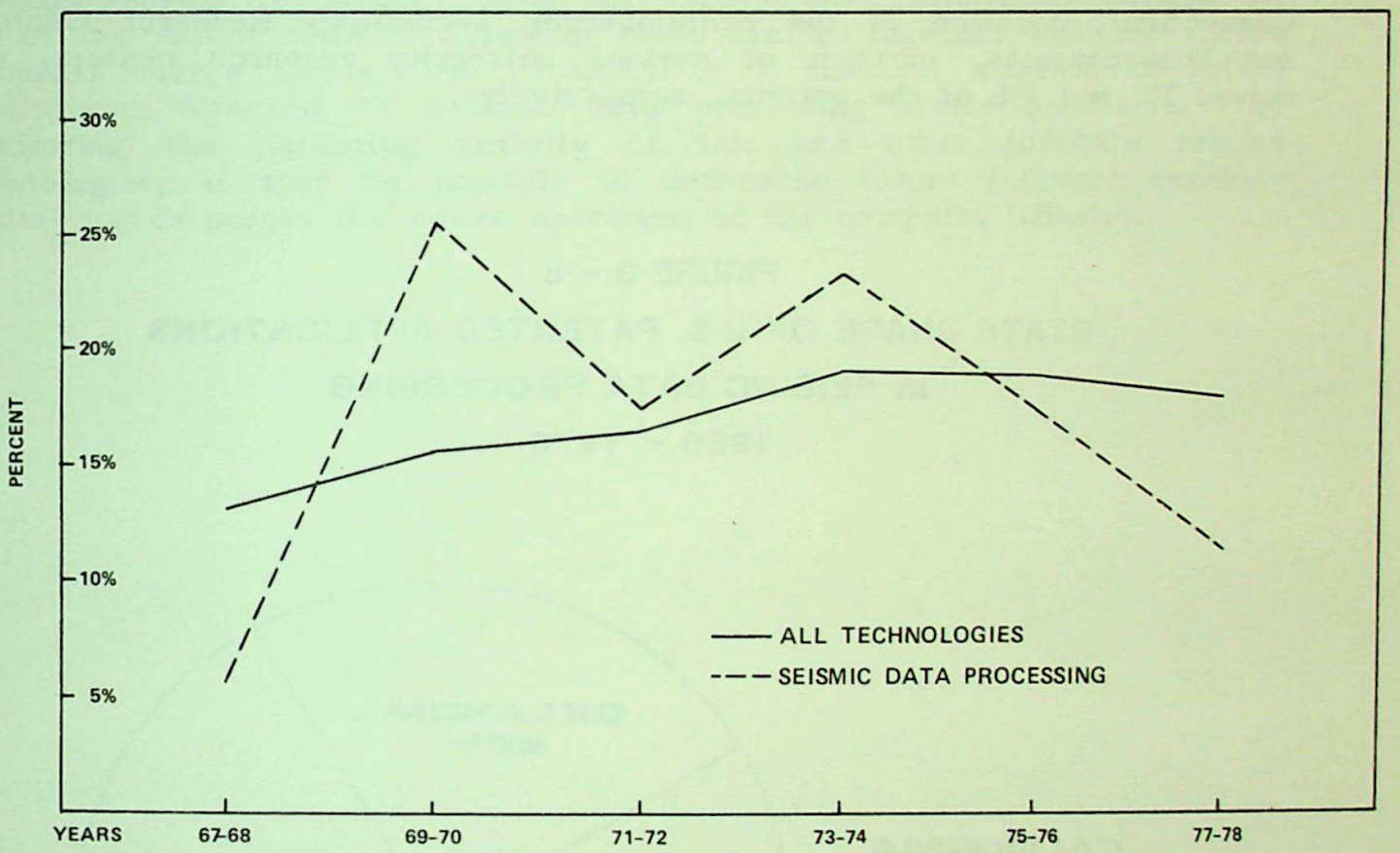
FOREIGN ORIGIN PATENTING IN SEISMIC DATA PROCESSING 1960 - 1978



ogies for the period 1963-1980 were awarded more patents than other foreign country except West Germany, received no patents in this technology. Likewise, Switzerland, which ranks fifth among foreign countries for the number of U.S. patents received, had no patents awarded in this technology to its resident inventors. Thus, by observing innovation in this area, as exemplified by patenting, one sees the residents of the U.S., France, U.K. and Canada dominating the technology.

Figure 3-5 compares the two-year percent shares of the 1967-1978 totals of foreign origin patented applications in seismic data processing and in the all-technology category.

FIGURE 3-5
TWO-YEAR PERCENT SHARE OF 1967-1978 TOTAL FOREIGN ORIGIN PATENTED APPLICATIONS: SEISMIC DATA PROCESSING vs. ALL TECHNOLOGIES



The rapid rate of growth of foreign origin seismic data processing patented application filings during the 1967-1974 period is shown by the increase in percent share from 5.7% in the 1967-1968 time period to 22.9% for the 1973-1974 period. However, from 1974 through 1978, the percent share declined steadily to a low of 11.4%. This decline can be partially attributed to the reluctance of inventors and assignees to file patent applications directed to software or algorithms when the PTO is rejecting such inventions.

---

*The two-year percent share is the number for the two year period divided by the total for the 1967-1978 period times 100.

As depicted by Figure 3-5, all technologies, as a group, consistently increased in yearly percent of patented applications from 1967 through 1974 and maintained a slight decline of 1.2% from 1974 through 1978. Thus, it can be seen that the fluctuations in patented application filing shown in the seismic data processing field are not merely a reflection of what is happening in all areas of technology.

Patent Activity By State

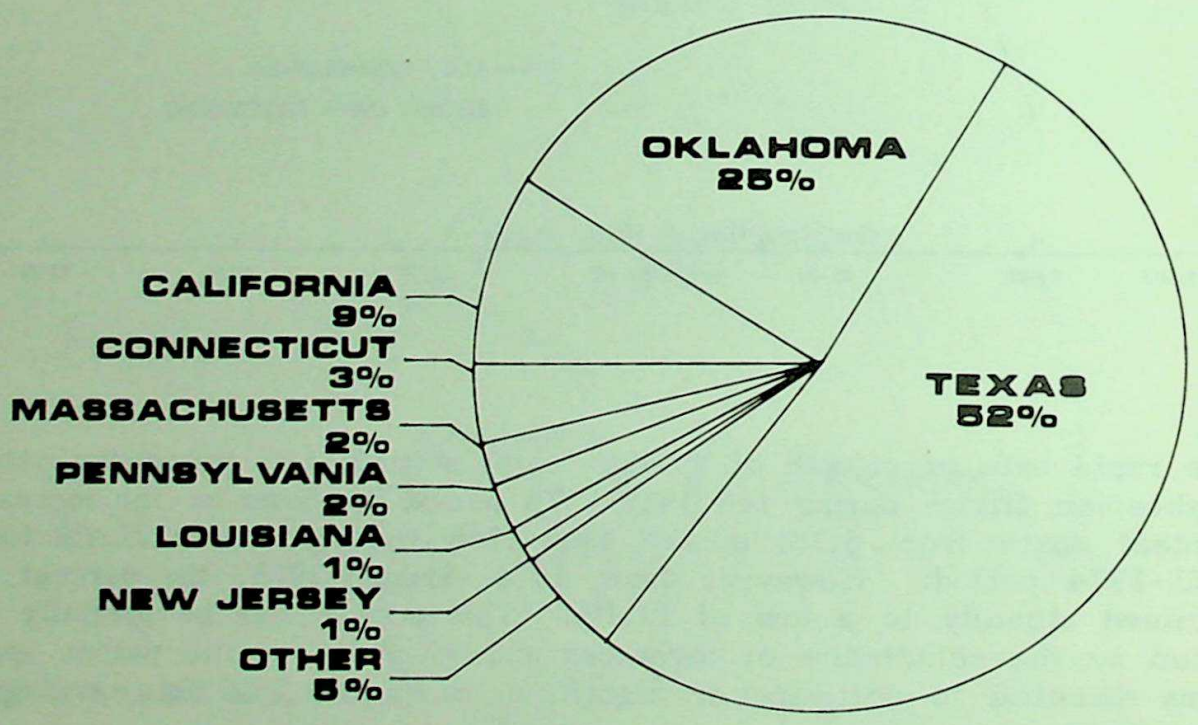
Figure 3-6 shows the percentage of patented applications by U.S. inventors from 1960 though 1978, by the state of the first listed inventor. Except for Alaska, the states having the largest commercial gas and oil fields had the largest number of patented inventions directed to processing seismic exploration data. Texas and Oklahoma combined received 77% of all patents in this area. Other oil and gas producing states, such as California, Pennsylvania and Louisiana, together received only 12% of the patents. Connecticut, location of the Schlumberger Technology Research Center, and Massachusetts, location of various university research centers, received 3% and 2% of the patents, respectively.

FIGURE 3 - 6

STATE SHARE OF U.S. PATENTED APPLICATIONS

IN SEISMIC DATA PROCESSING

1960 - 1978



When compared to patent activity by state for all technologies, California, the state having the largest number of resident patentees over this time period, received 9% of the patents in this technology. New York's resident inventors, who received the second largest number of patents over this time period, stand out for receiving less than 1% of the patents in this technology.

CONCLUSION

The rapid growth of general purpose computer usage over the last decade, both for industrial and home use, has resulted in a greater demand for software. This growth, along with innovations developed to apply software to new and existing technologies, has led to an increased number of patent applications in the many fields which utilize computers. With the Supreme Court's decisions of Diehr and Bradley, new vistas have been opened for artisans seeking to protect their software related inventions through the use of the patent system. Viewing these factors together with the world's expanded energy needs, the prospect of a sizeable increase in patent applications directed to seismic data processing seems inevitable. By monitoring the patenting activity of this and other software related technologies, it may be possible to determine future software developmental trends across the entire spectrum of the computer industry.

TECHNOLOGY ASSESSMENT & FORECAST

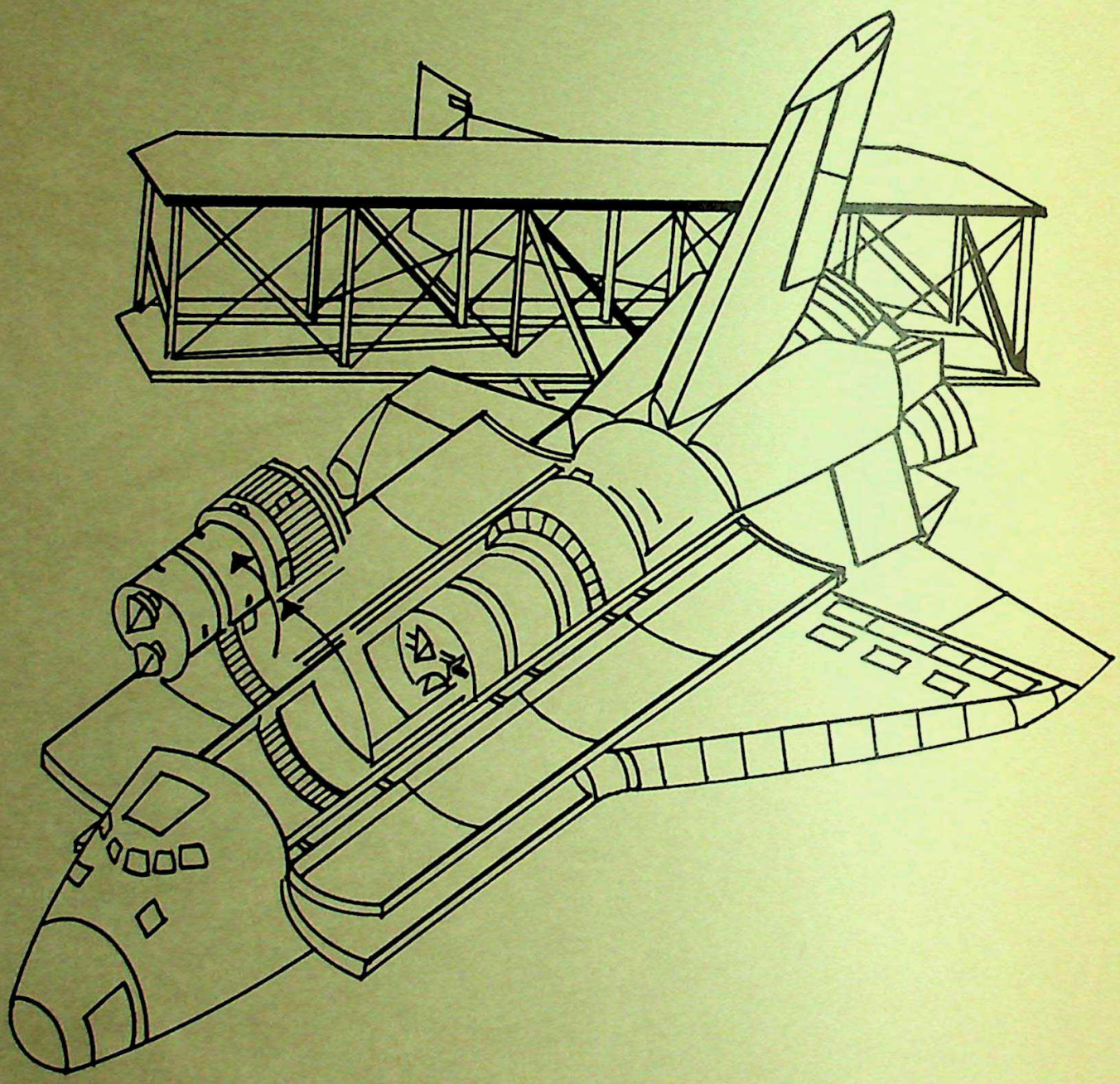
The Patent System added th
interest to the fire of genius.

SECTION IV - AEROSPACE TECHNOLOGY PATENTING
A Demonstration of the Use of the U.S. Patent File

Case I - The Patent File: A Tool for Historical Review 79

Case II - The Patent File: A Valuable Research Tool 88

Case III - The Patent File: A Bibliographic Data Source 91



INTRODUCTION

Expanding Alternatives in Patent Information Application

The massive collection of literature born from two centuries of activity in the American patent system has long been the center of attention in the traditional patent community. Generally known as the "patent file", this collection of information continues to grow as more than a hundred thousand patent applications are filed each year. This file is regularly accessed by patent agents and attorneys, professional searchers and Federal patent examiners to determine patentability and patent validity. There is emerging, however, a number of alternative perceptions of patent file usage on the part of those who had not been previously patent-oriented in their research approach.

Recognizing that the patent literature has chronicled most major technical developments in the past two hundred years -- reflecting the who, what, when, and where of technological change -- a new generation of "users" has begun to access the patent file from a number of differing perspectives. Policy makers, corporate strategists, laboratory researchers, economists, stock exchange analysts, and others are realizing the value of the patent file as a useful research tool.

This report is intended to demonstrate how the patent file is being tapped in these non-traditional ways. By way of example, a specific technology, "Aerospace", is selected as the demonstration model. The point should not be lost, however, that the patent file contains a wealth of substantive information about almost every technology.

The aerospace field was chosen not only because of its widespread appeal, but also because it reflects the rapid pace of technological change. Although there is extensive substance in the file for scholars to survey, the present purpose is not to undertake an in-depth treatise of aerospace patent technology. Rather, the principal focus in this report will be the patent file itself, and its potential use.

BACKGROUND

Criticality of Information Flow

It is difficult to overstate the importance of information in the invention, innovation, and education processes. No field better demonstrates this than aerospace technology. Even before people such as Samuel Pierpont Langley began to apply the mathematics of Bernoulli to give "lift" to the wings of man, the names and achievements of aviation's pioneers were numerous. Viewing and assessing information about the results of past struggles, innovators such as the Wright brothers, Sikorsky, de Havilland, Goddard, and many others built upon previous successes and failures, and applied themselves to further advance the state-of-the-art.

Thus, the act of innovation is based upon modifying existing technology or applying the new knowledge which flows from research and development (R&D). Efficiency in R&D depends on the use of the most relevant information. All ideas come from information -- all discoveries or new developments begin with it.

Today, "change" in the aerospace industry and, indeed, most technological fields is accelerating at a rapid pace; so much so that the "Wrights" of today may no longer be able to build upon, or even know about, the work of previous innovators. This is an age of "Infosystems" -- a time when the increasing flow of technical information, so vital to any innovative effort, requires enhanced monitoring and reporting techniques. The problem, then, is to identify and exploit the resources of information, especially those which are comprehensive in character and particularly representative of technological change. The patent file is such a resource.

The Patent File, A Record of Change

Throughout the world, national patent systems have been developed specifically to promote production of new technology, encouraging invention by a system of rewards. For example, in the U.S. and other countries, the act of disclosing a new discovery is rewarded with a measure of protection embodied in a patent -- a government grant recognizing, for a set time period, the inventor's exclusive rights to the invention. Thus, patents are frequent products of R&D and invention.

The occasion of each "patent grant" represents a recorded technological event -- an event particularly appropriate for monitoring -- an event involving a development which is, by definition in most national legal systems, "new." Patent documents, therefore, identify principal agents of technological change and graphically describe the nature of the new developments. Wide utilization of national patent systems results in a virtual stream of patent grants -- in effect, a measurable flow of technology.

The continuous flow of new information generated in the patenting process long ago called for the design and maintenance of an extensively categorized search file where disclosure could be stored for retrieval, chronologically and by technology. Hence, the U.S. Patent Classification (USPC) System was established and, in its present form, identifies more than 370 major categories or classes of technology, subdivided into over 108,000 subcategories or subclasses. In all, this file has grown to include a total of more than 24 million technical documents. Importantly, this collection continues to grow. Each week, nearly 5000 copies of U.S. patent documents (new U.S. patents and their cross references) are added to the patent file.

Opening the patent file to any particular category of interest can result in an outpouring of information of unexpected depth and detail. To illustrate the type of information readily available, and to set the stage for demonstrating the use of this resource as a research tool, we turn now to the aerospace-related categories.

Aeronautics and the Patent File

A great quantity of patent literature, bearing directly or indirectly upon the aerospace industry, is stored within the more than 370 major invention class categories of the U.S. patent file. The USPC System delineates a number of categories which are especially pertinent. For example, the subject matter included in Class 244 is entitled "Aeronautics" and ranges in content from balloons to space shuttles, aircraft doors to autopilot systems, kites to rockets. In addition to Class 244, there are a number of other areas of the patent search file where aerospace-related technology may be found. For example, aircraft power plants and power plant controls are found in Class 60. Classes 415 and 416 include propellers and rotor systems, and Class 428, which contains various stock materials, is where lightweight, high strength materials are classified. The number of USPC categories which are "related," in one way or another, to the aerospace industry is considerable since many fields of inventive endeavor have multi-industry application.

To simplify this illustration, attention will be limited to Class 244, "Aeronautics." On the next page are displayed USPC Manual pages pertaining to Class 244. Subclass areas pertinent to the discussion which follows are highlighted. For each of the subclasses listed, as well as for the remainder of the 108,000 subclasses in the system, extensive and detailed definitions of scope and content are maintained by the U. S. Patent and Trademark Office.

The "Aeronautics" class is divided into approximately 300 subclasses where more than 40,000 U.S. patent documents are filed. The subclass categories cover all types of aircraft (heavier and lighter-than-air), missiles, spacecraft, and helicopters. Some categories relate to particulars of aircraft design, i.e., wings and wing arrangements, landing gear, and various other structural details. Further included in Class 244 are auxiliary devices particularly designed for, or directly related to, aircraft, such as restraining and retarding devices, parachutes, and landing field arrangements. Kites and hang gliders are also found in this patent file area.

The "Aeronautics" file, then, can be seen literally as a library of aerospace engineering, a library where both the newest and the oldest technology are stored -- with all the developments and developers catalogued and chronicled in-between. This brings us to the first case to be made for the value of this resource as a tool for historical review.

AIRCRAFT STRUCTURE
129.4 .Details
129.5 ..Closures
118.3 ...Door
129.6 ..

1 R MISCELLANEOUS
1 N ..Noise abatement
1 A ..Lightning arresters and static eliminators
1 TD ..Trailing devices
2 COMPOSITE AIRCRAFT
3 .Trains
3.1 MISSILE STABILIZATION OR TRAJECTORY CONTROL
3.11 .Remote control
3.12 ..Trailing wire
3.13 ..Beam rider
3.14 ..Radio wave
3.15 .Automatic guidance
3.16 ..Optical (includes infrared)
3.17 ...Optical correlation
3.18 ...Celestial navigation
3.19 ..Radio wave
3.2 ..Inertial
3.21 ..Attitude control mechanisms
3.22 ...Fluid reaction type
3.23 .Stabilized by rotation
3.24 .Externally mounted stabilizing appendage (e.g., fin)
3.25 ..Removable
3.26 ..Sliding
3.27 ..Collapsible
3.28 ...Longitudinally rotating
3.29 ...Radially rotating
3.3 ..Extending beyond rear of missile
158 SPACECRAFT
159 .Space station
160 .Reentry vehicle
161 ..Rendezvous and docking
162 ..Manned
163 ...Environmental control
164 .Attitude control
165 ..By gyroscope or flywheel
166 ..By magnetic effect
167 ..By gravity gradient
168 ..By solar pressure
169 ..By jet motor
170 ..By nutation damper
171 ..With attitude sensor means
172 .With propulsion
173 .With solar panel
4 R AIRCRAFT, HEAVIER-THAN-AIR
4 A ..Body attached
5 .Airplanes, weight diminished by bouyant gas
6 .Airplane and helicopter sustained
7 R ..Convertible
7 A ....Rotary wing
7 B ....Tail sitters
7 C ....Tilting wing
8 .Airplane and auto-rotating wing sustained
9 .Airplane and paddle wheel sustained
10 .Airplane and cylindrical rotor sustained
11 .Airplane and beating wing sustained
12.1 .Airplane and fluid sustained
12.2 ..Circular
12.3 ..Dual propulsion
12.4 ..Thrust tilting
12.5 ..With thrust diverting
12.6 ..Channel wing
13 .Airplane sustained
14 ..Aerial torpedoes
15 ..Fluid propelled
16 ..Glider
17.11 .Helicopter or auto-rotating wing sustained, i.e., gyroplanes
17.13 ..Automatic or condition responsive control
17.15 ..With safety lowering device
17.17 ..With landing, mooring, or nonaerial propelling or steering gear
17.19 ..With auxiliary propulsion, counter-troque or steering device
17.21 ...Auxiliary rotor
17.23 ..Having plural lifting rotors
17.25 ..Lifting rotor having lift direction varying means
17.27 ..Lifting rotor supports, e.g., pylons
19 .Paddle wheel sustained
20 ..Feathering
21 .Cylindrical rotor sustained
22 .Beating wing sustained
23 R .Fluid sustained
23 A ...Lifting thrusters
23 B ...Dual propulsion means, horizontal and vertical
23 C ...Circular configuration
23 D ...Thrust diverters
24 AIRCRAFT, LIGHTER-THAN-AIR
25 .Airships with sustaining wings
26 .Airship and helicopter sustained
27 .Airship and paddle wheel sustained
28 .Airship and beating wing sustained
29 .Airship and fluid sustained
30 .Airships
31 .Balloons
32 ..With parachutes
33 ..Captive
34 R AIRCRAFT SUSTENTATION
34 A ..Annular airfoils
35 R .Sustaining airfoils
35 A ...Compressible flow
36 ..Lifting fuselages
37 ..Lifting struts
38 ..Resiliently mounted
39 ..Rotatable
198 ..With lift modification
199 ...By vortex generator or dissipator
202 ...By characteristic of airfoil's skin
203 ...Variable
204 ....With landing gear
205 ....Condition responsive
206 ....By controlling boundary layer
207 .....With ionic or electrostatic surface
208 .....With rotating member
209 .....With blowing
210 .....And suction
211 .....With suction
212 .....With nose slot
213 .....Having trailing edge flap
214 .....Having trailing edge flap
215 ....By flap and/or spoiler
216 .....At leading edge
.....At trailing edge
.....Variable gap type, e.g., "Fowler Flap"
217 .....Plural, relatively pivotable
218 ....Area
219 ...Camber
45 R ..Arrangement
45 A ....Canard
46 ...Variable
47 ....Dihedral
....Incidence
....Folding
AIRCRAFT PROPULSION AND STEERING ON LAND OR WATER
AIRCRAFT, STEERING PROPULSION
.Fluid
AIRCRAFT POWER PLANTS
52 ..Starters
53 R ..Air intakes
53 A .Mounting
53 B .Arrangement
54 ..Tilting
55 .Radiator arrangement
56 .Auxiliary
57 .High altitude
58 .Transmission of power
59
60

SPACECRAFT

HELICOPTERS

AIRCRAFT SUSTENTATION

CASE I

THE PATENT FILE: A TOOL FOR HISTORICAL REVIEW

From Balloons to Spacecraft

The history of aerospace technology is all there in the patent file, -- the early glider of Lilienthal (Fig. 1), the delicate fabric-covered tubing crafted by Orville and Wilbur Wright (Fig. 2), and the hydro-aeroplanes of Glenn H. Curtiss. Ruben Jasper Spalding's "winged jacket" can also be found in the patent file. His 1889 patent (Fig. 3) illustrates an aeronaut dramatically suspended from a floating balloon, strapped into a jacket with huge feathered wings and tail -- a contraption he entitled "Improved Flying Machine."

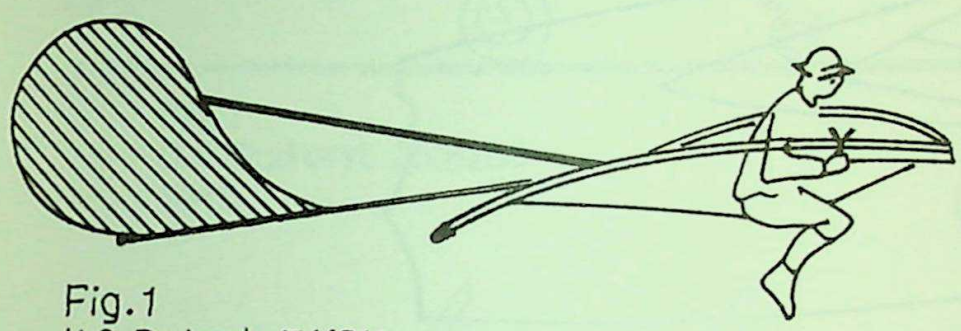


Fig. 1
U.S. Patent 544816
1895

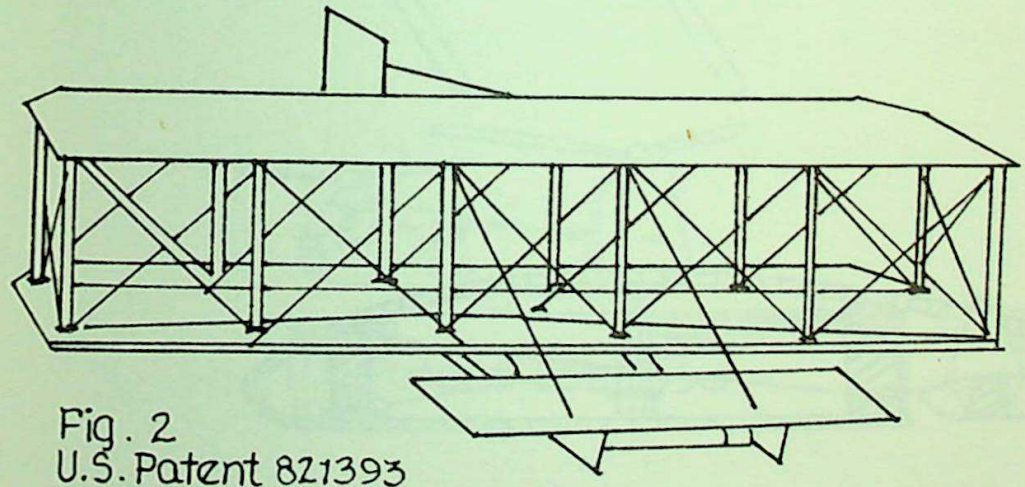


Fig. 2
U.S. Patent 821393
1905

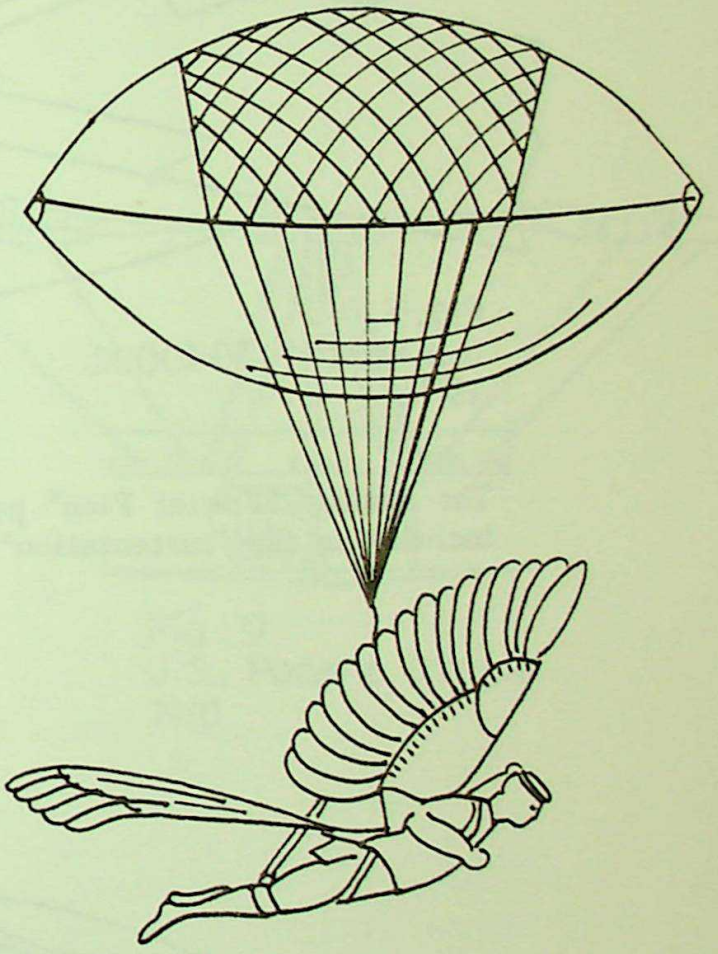


Fig. 3
U.S. Patent 398984
1889

Accessing the patent file is like opening an encyclopedia to a desired topic. The difference is that patents present an unequaled degree of subject detail and breadth. In "Aeronautics," Class 244, one can easily trace the innovative steps in such specific subclass groupings as aircraft sustentation, spacecraft and helicopter design.

Landmark disclosures of airfoil designs, including Whitcomb's supercritical airfoil and the well-known Kline-Fogleman wing (Fig. 4), are recorded within the "Aircraft Sustentation" grouping of subclasses. Boundary layer control discoveries are within this category, as well. These are exemplified by the disclosure in the 1976 patent to Farris (Fig. 5), successfully applied in Boeing's YC14, where the aircraft engine itself is mounted over the wing so that air is accelerated across the wing and flaps to increase lift for short takeoff and landing.

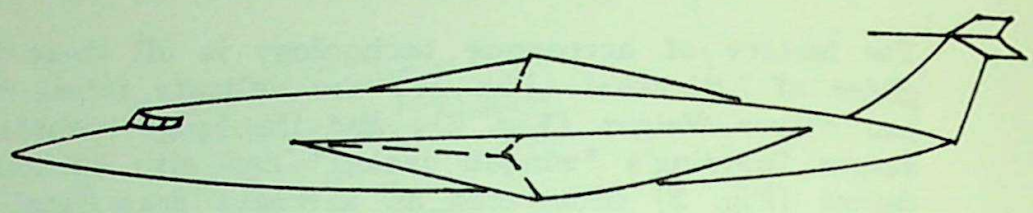


Fig. 4
U.S. Patent 3706430
1972

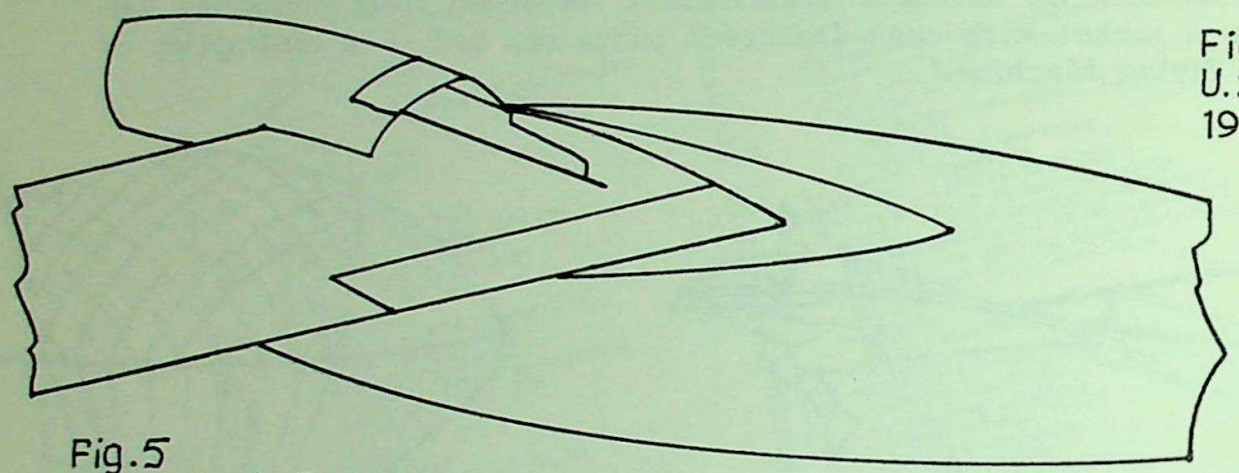


Fig. 5
U.S. Patent 3940092
1976

The famous "Fowler Flap" patent granted to H.D. Fowler in 1928 (Fig. 6), is also included in the "sustentation" subclass grouping.

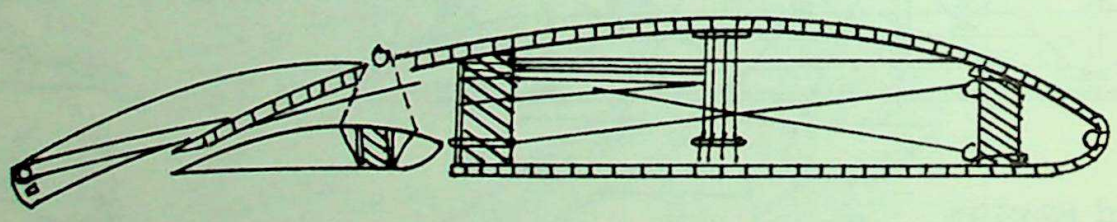


Fig. 6
U.S. Patent 1670852
1928

Milestones in helicopter progress are found in a number of Class 244 categories which are especially designed for vertical take-off and landing craft (VTOL). Included are inventions by Sikorsky (Fig. 7) and Piasecki (Fig. 8) and even a rather elaborate system of rotating box kites described in 1910 by that prolific inventor Thomas A. Edison (Fig. 9).

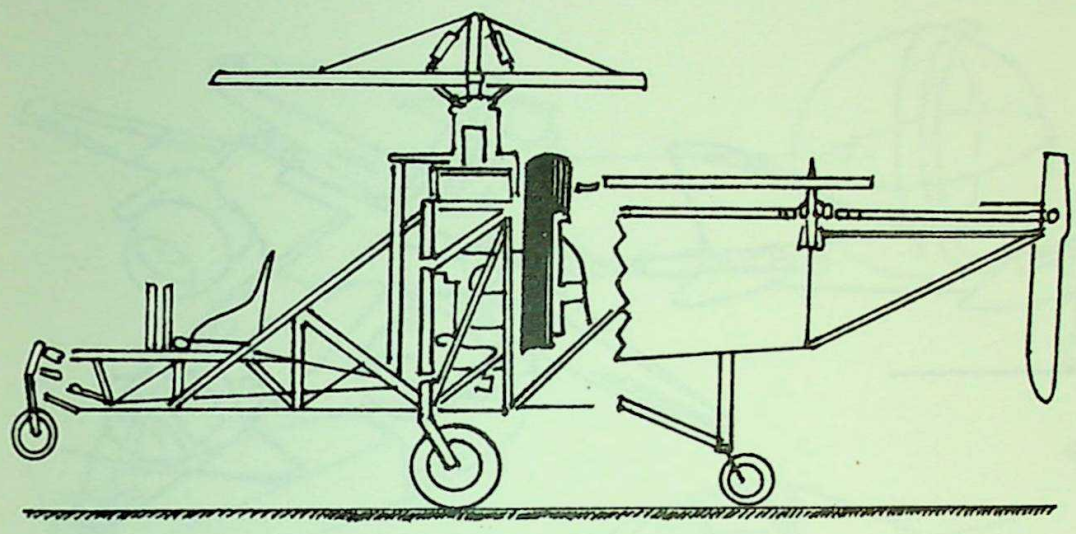


Fig. 7
U.S. Patent 2318260
1943

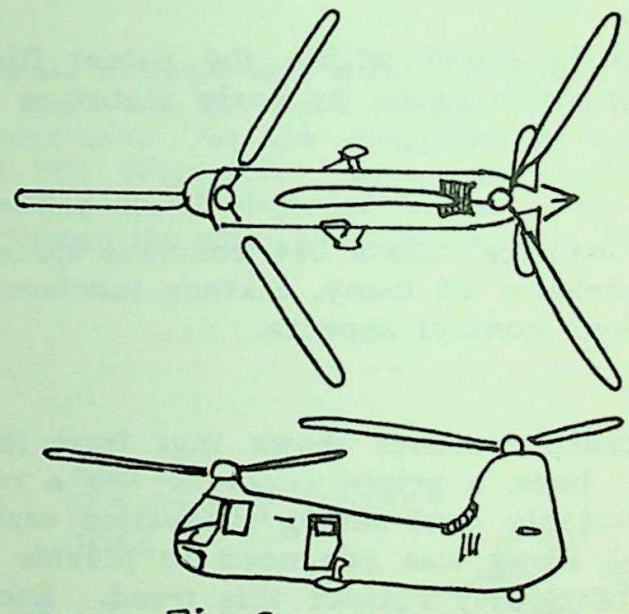


Fig. 8
U.S. Patent 2507993
1950

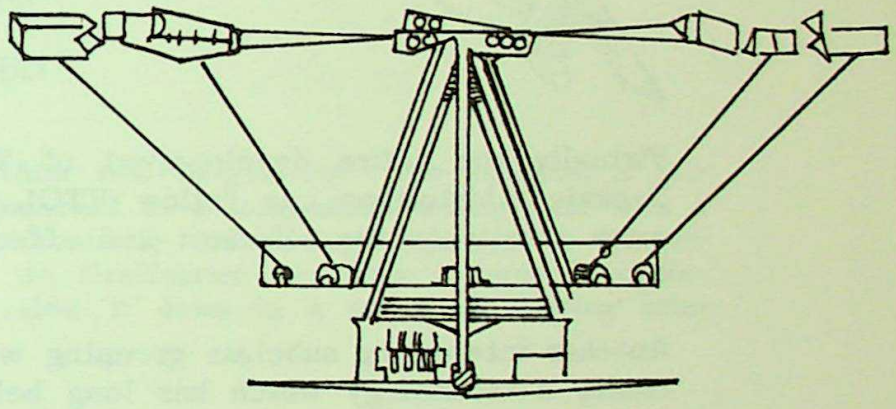


Fig. 9
U.S. Patent 970616
1910

Evident in more recent helicopter history are attempts to convert designs originally developed for the rigors of combat to cosmopolitan commuter craft -- an effort obviously requiring more than the addition of attractive decor. Design concepts based upon the need for maneuverability and rugged durability must also accommodate environmental concerns and the absolute necessity for passenger comfort and safety. Representative of this trend are the relatively large number of vibration dampening inventions set forth in the "VTOL/helicopter" subclasses.

A review of VTOL history cannot avoid the significance of the "Harrier" type craft disclosed in U.S. Patent 4,004,755, granted to Ralph Spenser Hooper of England (Fig. 10), where rotatable nozzles direct a jet stream either vertically or horizontally. More recent modifications have involved rotation of the engine itself to vary thrust direction as shown in U.S. Patent 4,116,405, granted in 1978 to inventors Bacchi and Kress of New York (Fig. 11).

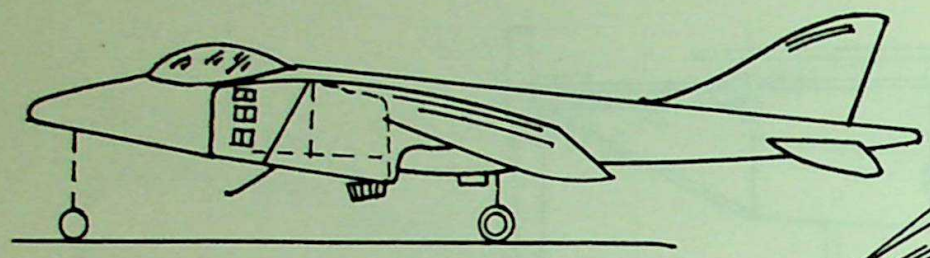


Fig. 10
U.S. Patent 4004755
1977

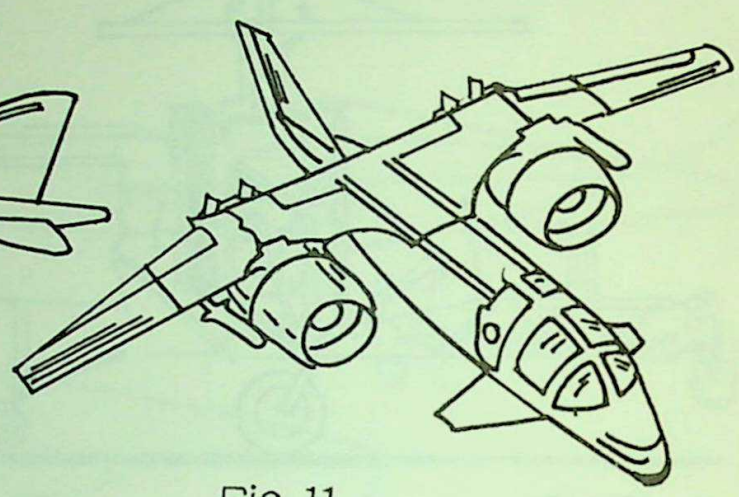
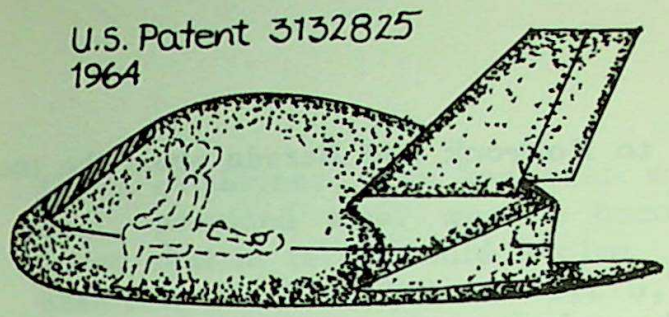


Fig. 11
U.S. Patent 4116405
1978

Virtually the entire development of VTOL craft is found within the patent file. Technical historians can follow VTOL craft progression from its early status as a mere novelty to the efficient and effective designs of today.

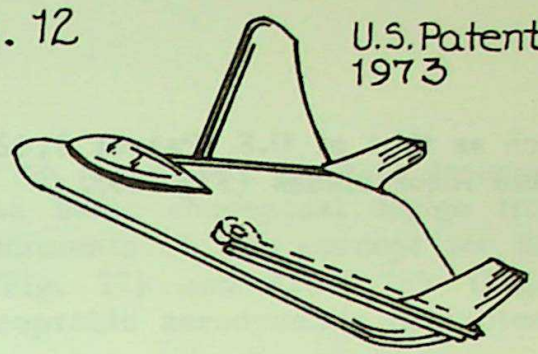
Another interesting subclass grouping within "Aeronautics" Class 244 concerns spacecraft, a technology which has long held the fascination of many. Sixteen subclasses accommodate a variety of vehicles and their various control aspects.

A review of the substantive content of "spacecraft" patents shows that from the very start of the U.S. space program, cost has been a prime concern. As a result, the idea of a space shuttle was seen as a viable cost-saving innovation early in the program. In the early 1960's, a wave of ideas was advanced to provide a versatile and reusable spacecraft, and the patents clearly reflect this trend. Even before April of 1961, when the Russian astronaut Yuri Gagarin made his historic orbit of the Earth, numerous requests for patent grants presented a variety of shuttle-type craft that, allegedly, could be launched into space and safely returned for reuse. Early designs included diverse forms of variable geometry or completely retractable wing arrangements. The intent, of course, was to provide a streamlined craft that could be efficiently launched into orbit, reenter the atmosphere, deploy wings, and land conventionally at existing airfields. A large assortment of patents (Fig. 12) present variations on this theme.

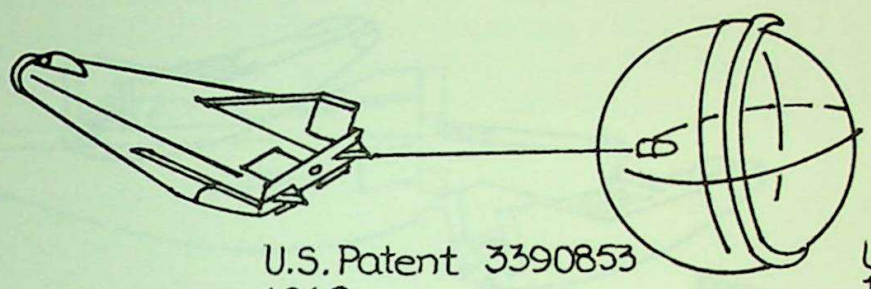


U.S. Patent 3132825
1964

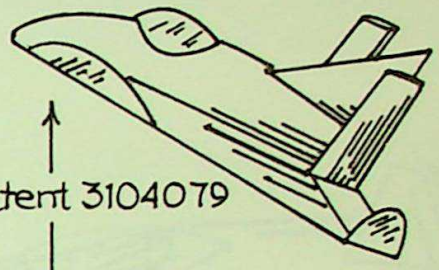
Fig. 12



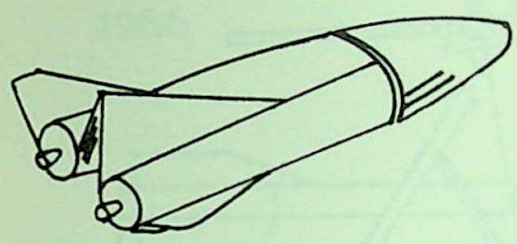
U.S. Patent 3743218
1973



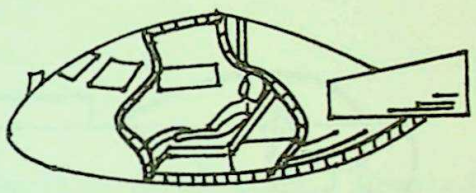
U.S. Patent 3390853
1968



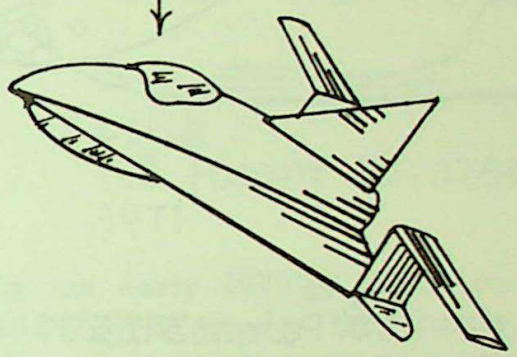
U.S. Patent 3104079
1963



U.S. Patent 3269673
1966

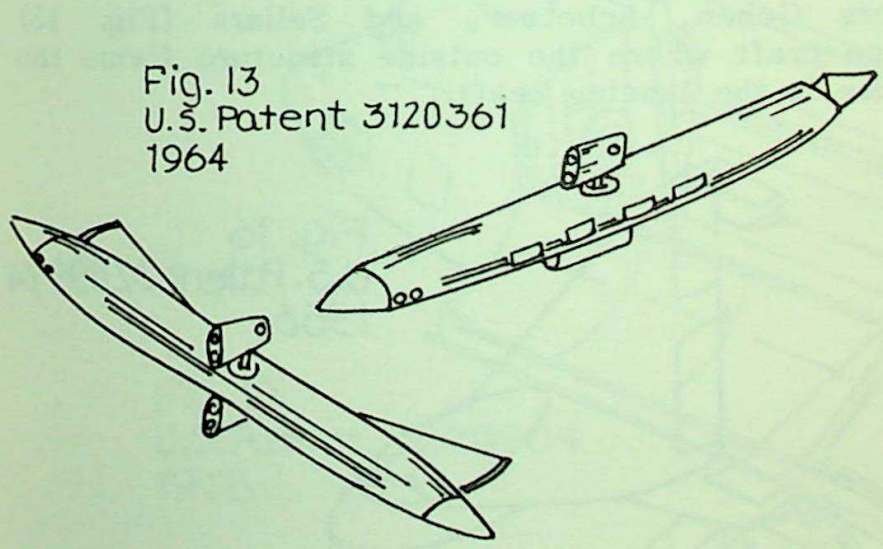


U.S. Patent 3090580
1963



Most ideas, although not always practical in nature, show real imagination. For example, a patent to Riebe and Lockwood suggests a craft that is launched in a longitudinal arrangement with a low aspect ratio (for low drag) and is then landed transversely with a high aspect ratio (for increased lift) (Fig. 13). In a 1964 patent, Albert de Graffenried describes a large "variable-area trailing sheet" deployed behind a spacecraft to slow it down in a series of skipping maneuvers through the outer atmosphere (Fig. 14).

Fig. 13
U.S. Patent 3120361
1964



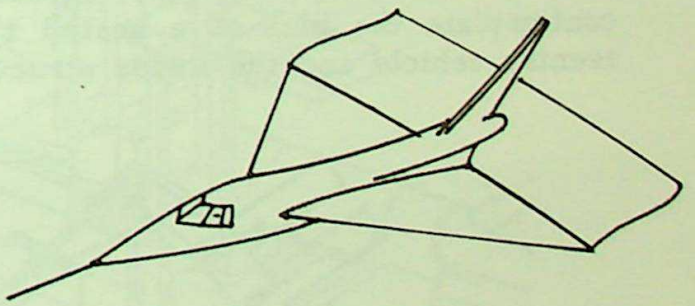


Fig. 14
U.S. Patent 3160366
1964

Designs such as that of U.S. Patent 3,428,271 to Hollrock and Barzda show the use of deployable rotor blades (Fig. 15).

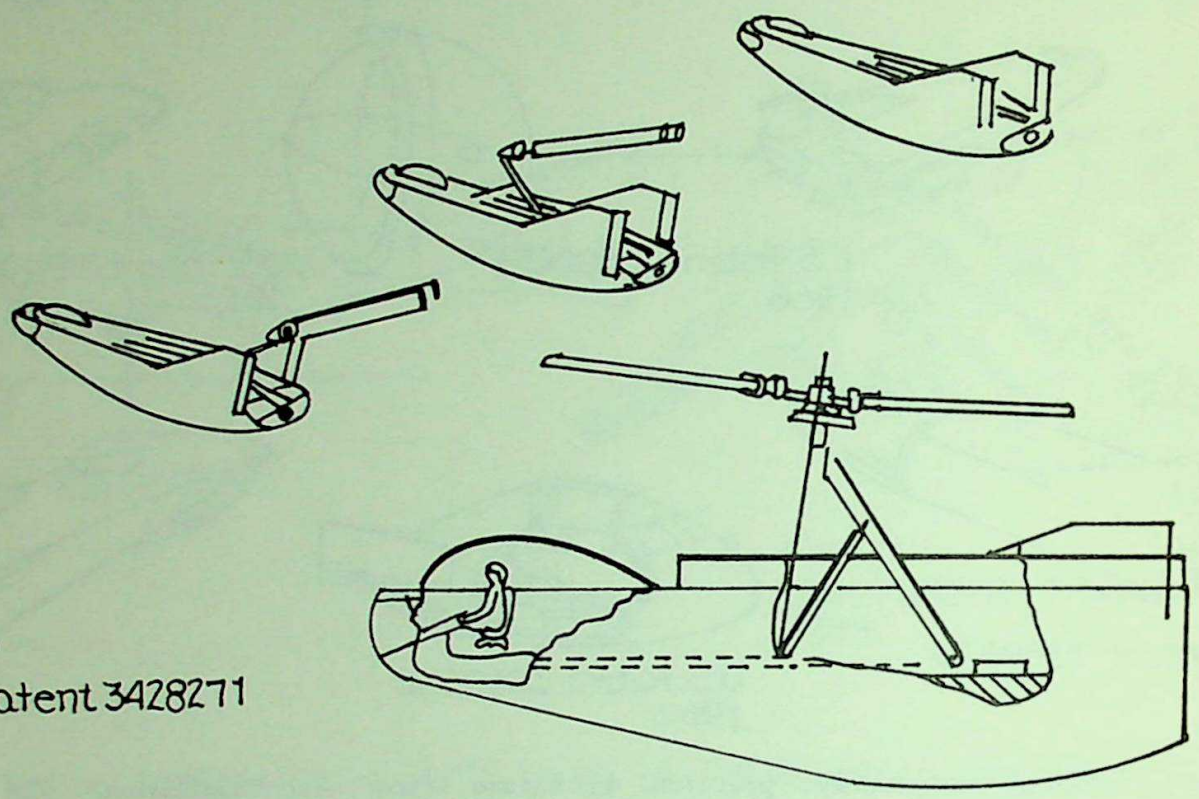


Fig. 15
U.S. Patent 3428271
1969

Other patents involve inflatable structures designed to serve alternatively as heat shields for the craft or as a lifeboat arrangement for astronauts stranded at sea. In U.S. Patent 3,289,974, inventors Cohen, Schetzer, and Sellars (Fig. 16) contemplate the idea of a nested type craft where the outside structure forms the reentry vehicle and the inside structure is the landing craft.

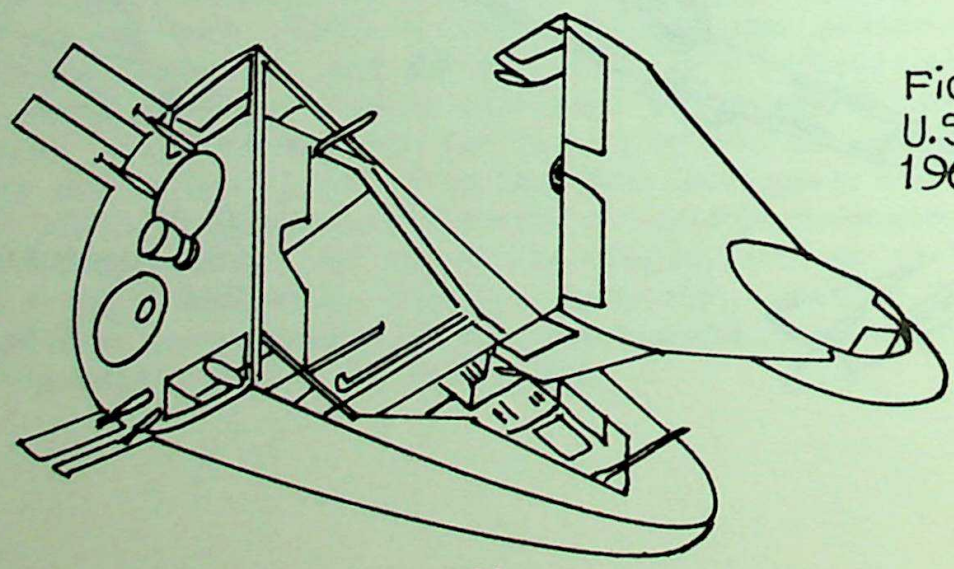


Fig. 16
U.S. Patent 3289974
1966

NASA employees, who had been working on hypersonic aircraft designs since around 1957, provided what was to become the basic conceptual design from which the latest shuttle form would evolve. Embodiments of this concept are illustrated, for example, in U.S. Patents 3,276,722 (Fig. 17) and 3,570,789 (Fig. 18). Such crafts use a lifting body design with acceptable aerodynamic characteristics in both hypersonic and subsonic flight.

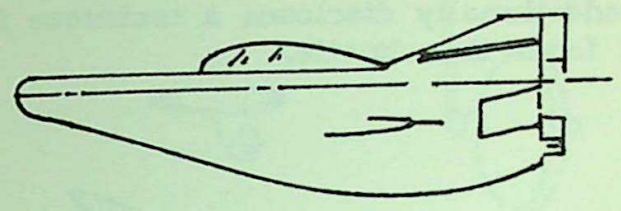


Fig 17
U.S. Patent 3276722
1966

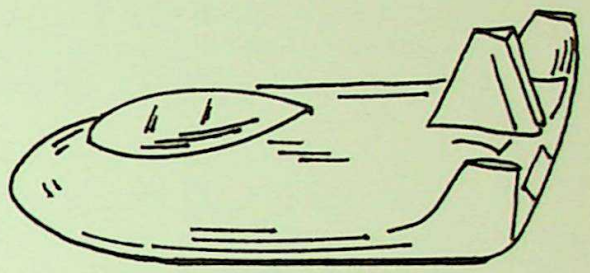


Fig.18
U.S. Patent 3570789
1971

Since the current space shuttle design was adopted in the early 1970's, recent research and developmental efforts have involved auxiliary systems for the shuttle. Such developments focus upon the shuttle's main purpose of ferrying cargo into outer space and its intended application for satellite servicing. A typical example is the "Module Exchange System" shown in U.S. Patent 4,079,904, granted in 1978 to four Canadian inventors (Fig. 19).

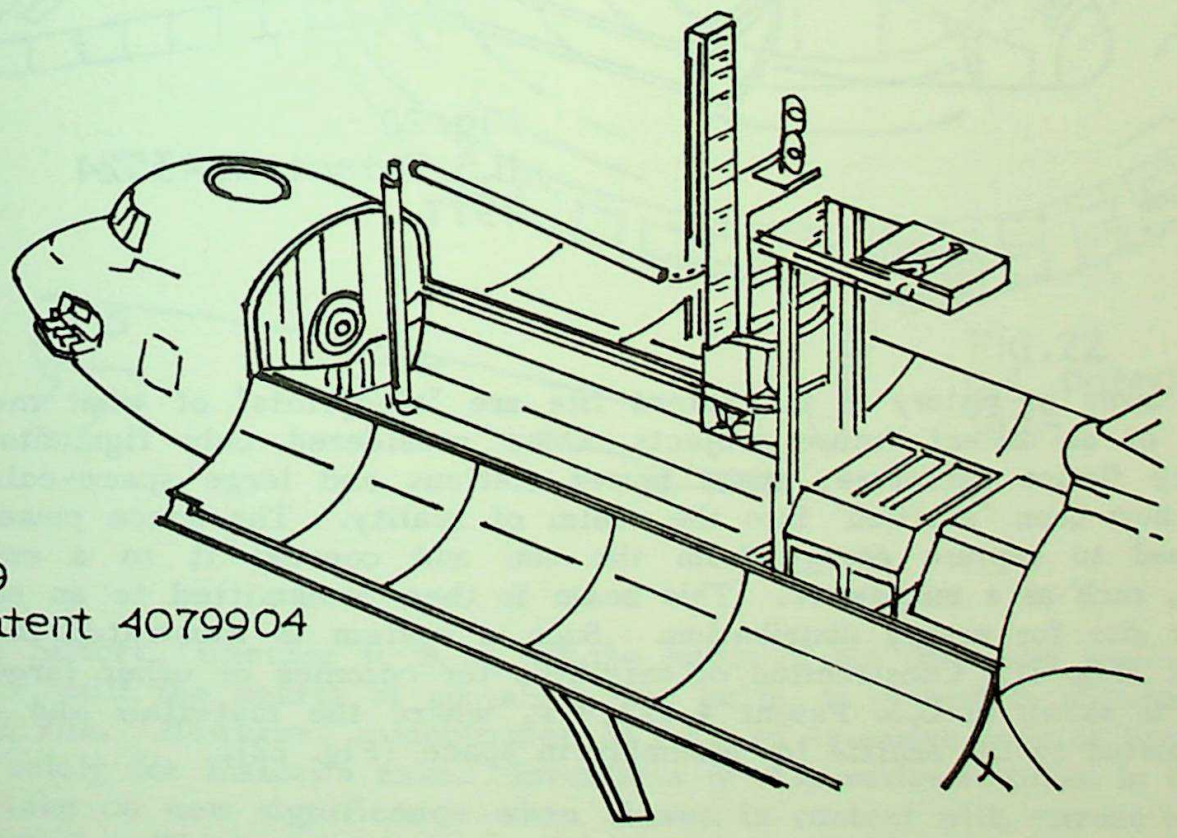


Fig. 19
U.S. Patent 4079904
1978

Interestingly, this patent discloses what may be termed a dramatic new concept in satellite technology, that of modular construction readily serviceable in situ. The system described includes service modules carried into space by a shuttle craft along with probes for retrieving and replacing defective satellites.

The patent literature in this area further shows how shuttle craft can be utilized for carrying satellites into orbit. An example of such a system is illustrated in General Dynamics' U.S. Patent 4,043,524, granted in 1977 to Californian inventors Dreyer and Huntington (Fig. 20). This patent additionally discloses a technique for giving the satellite an initial spin when released from the shuttle.

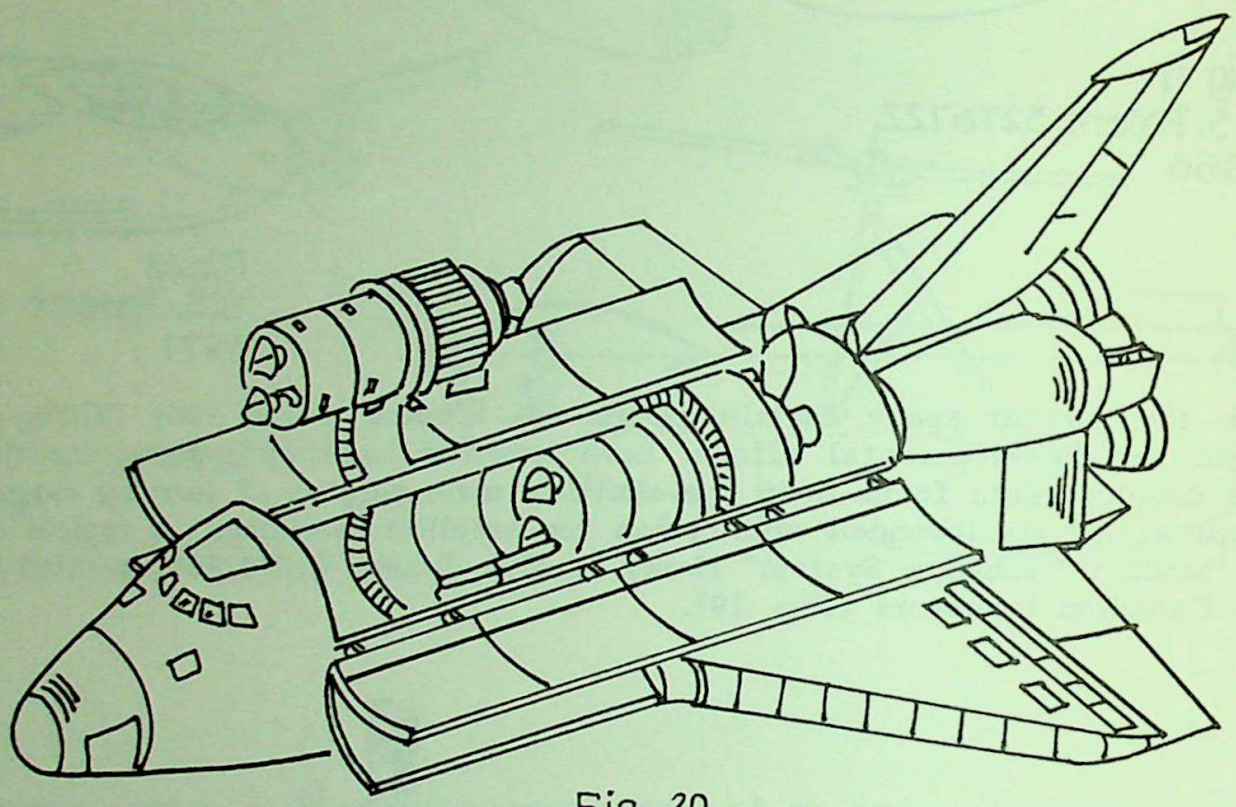


Fig. 20
U.S. Patent 4043524
1977

Filed away as history in the patent file are "blueprints" of what most of us still think of as distant future projects. Once considered only figments expressed in science fiction literature, space power stations and large space-colony structures have now been "shuttled" into the realm of reality. The space power stations are designed to capture energy from the sun and convert it to a coherent energy beam, such as a microwave. This beam is then transmitted to an earth-based receiver site for energy distribution. Such a system is illustrated in Glaser's 1973 patent (Fig. 21). Construction of satellites for colonies or other large space structures is shown in U.S. Patent 4,122,991, where the materials and equipment are transported by the shuttle for assembly in space (Fig. 22).

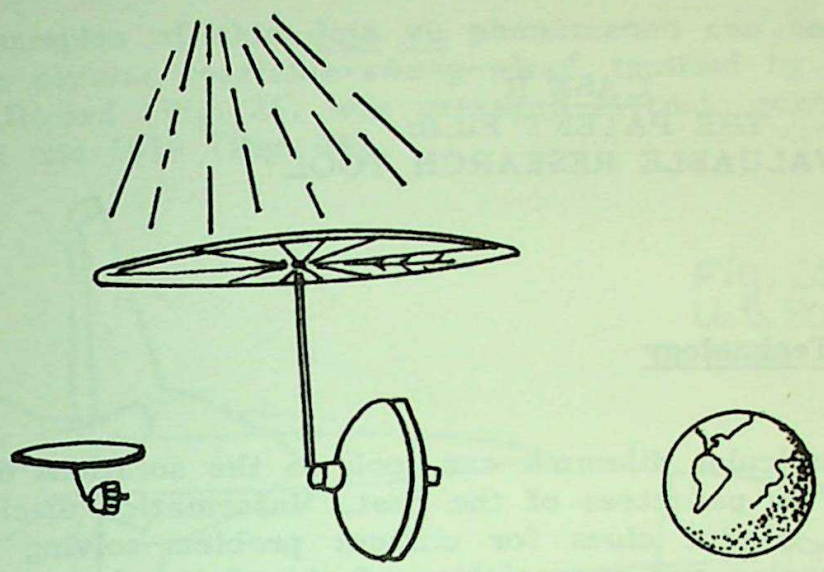


Fig. 21
U.S. Patent 3781647
1973

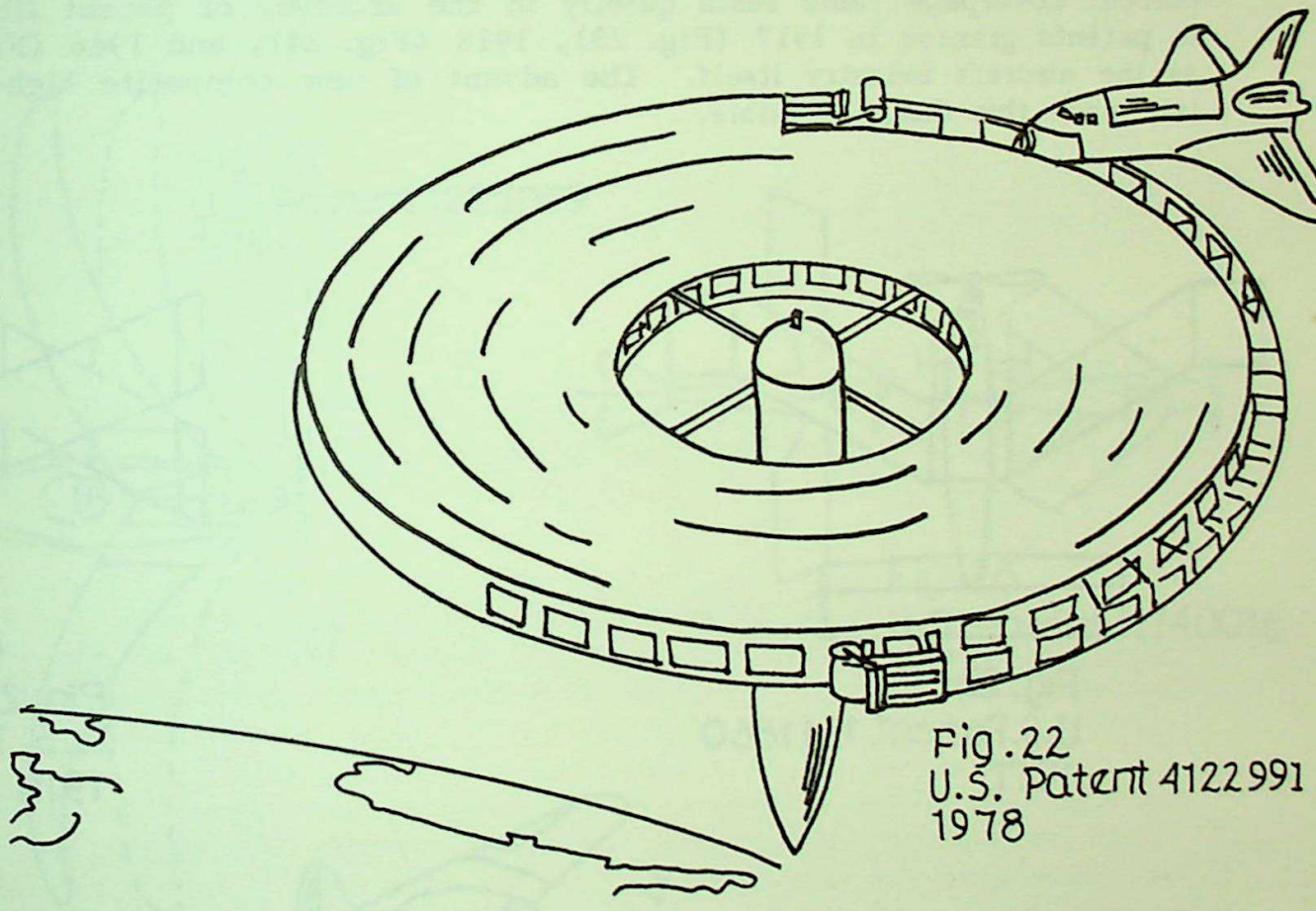


Fig. 22
U.S. Patent 4122991
1978

Aerospace history, whether it is to fill the minds of the university engineering student or to thrill the hearts of nostalgic aero buffs, is present in abundance within the patent file. However, maintenance of such an extensive body of literature has not been solely for history's sake. Inventions or discoveries recorded in the distant past can take on new significance when viewed in context with current technological experience. This point gives rise to another case for the research role of the patent file.

CASE II
THE PATENT FILE:
A VALUABLE RESEARCH TOOL

Patents as Problem-Solving Technology

Researchers faced with a particular dilemma can look to the solutions of the same or similar problems proposed by patentees of the past. Information disclosed in the patenting process can offer helpful clues for current problem-solving or, at the least, enhance one's understanding and appreciation of the state-of-the-art.

For example, it is interesting to note that many aerospace design concepts heralded as new in recent years originally appeared in basic form in the patent literature as much as sixty years ago. A case in point, the "forward-swept-wing" concept of current coverpage fame rests quietly in the archives of patent libraries, disclosed in patents granted in 1917 (Fig. 23), 1918 (Fig. 24), and 1946 (Fig. 25) -- as old as the aircraft industry itself. The advent of new composite high-strength materials made this design feasible.

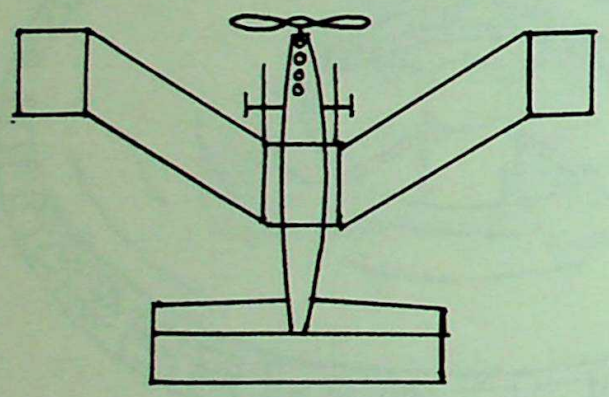


Fig. 23
U.S. Patent 1241860
1917

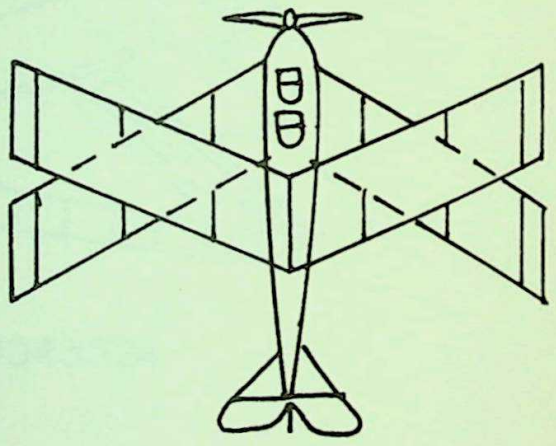


Fig 24
U.S. Patent 1264037
1918

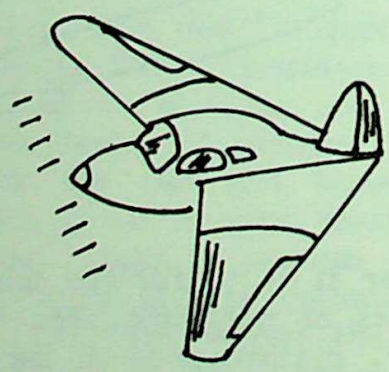


Fig 25
U.S. Patent 2406588
1946

Other examples of this deja vu phenomenon can be seen throughout the file. The currently popular "variable-sweep-wing" typified by the 1966 patent to Frenchman Armand Ricard (Fig. 26) was presaged in basic concept by patents granted in 1917 (Fig. 27) and 1929 (Fig. 28).

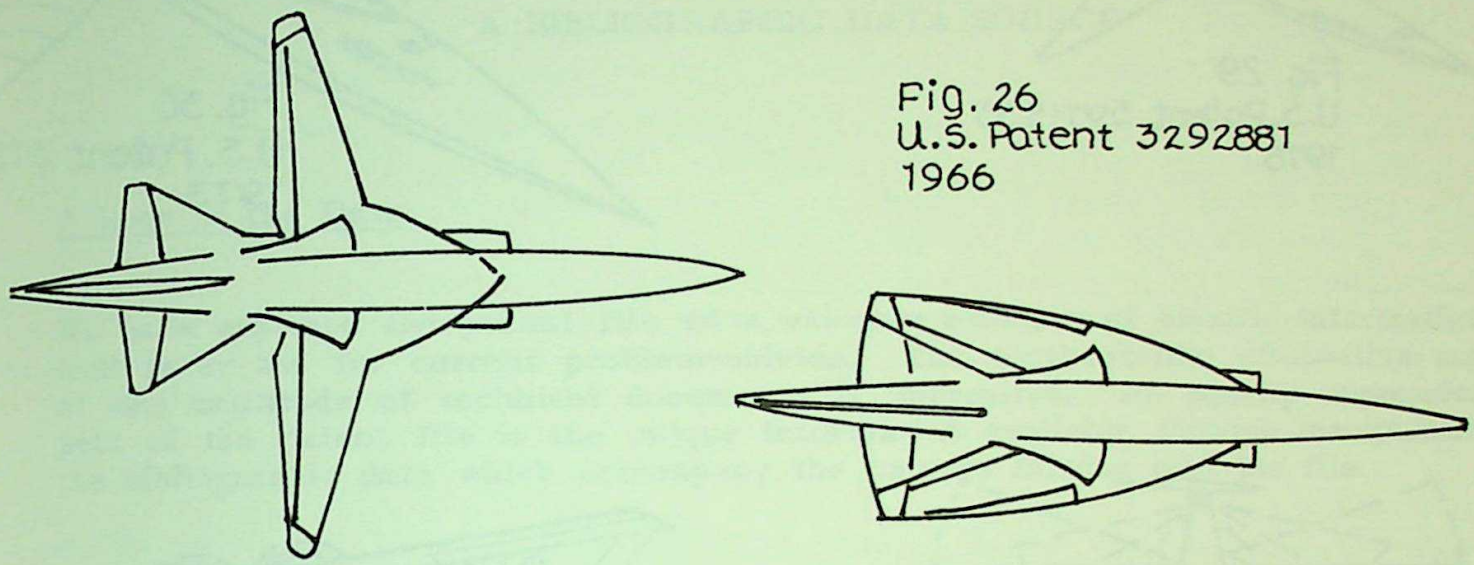


Fig. 26
U.S. Patent 3292881
1966

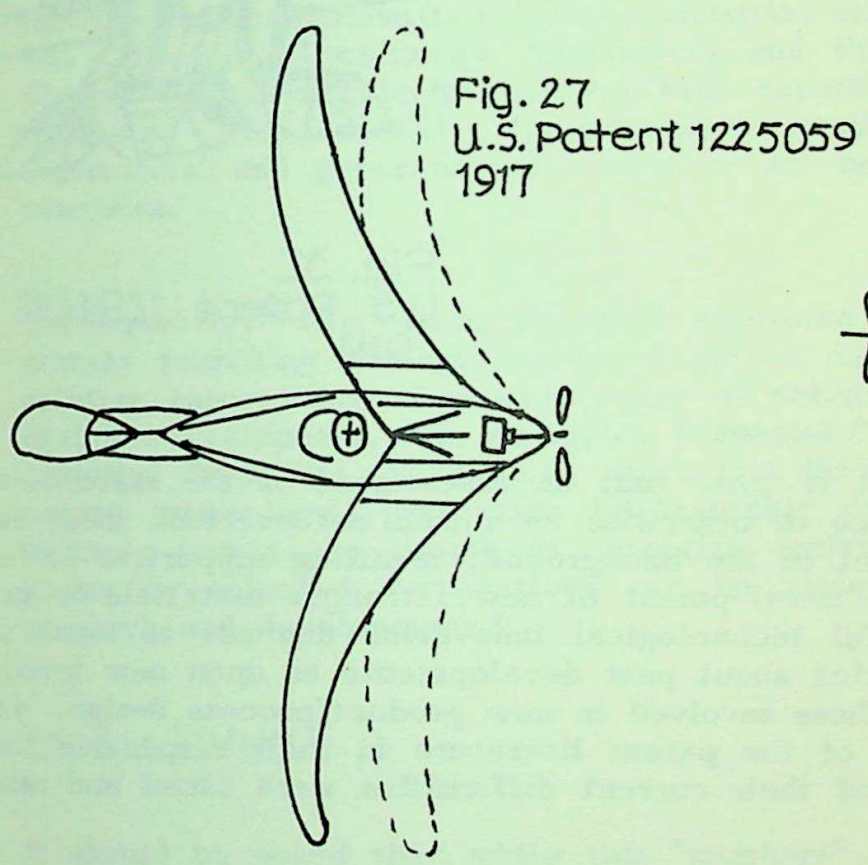


Fig. 27
U.S. Patent 1225059
1917

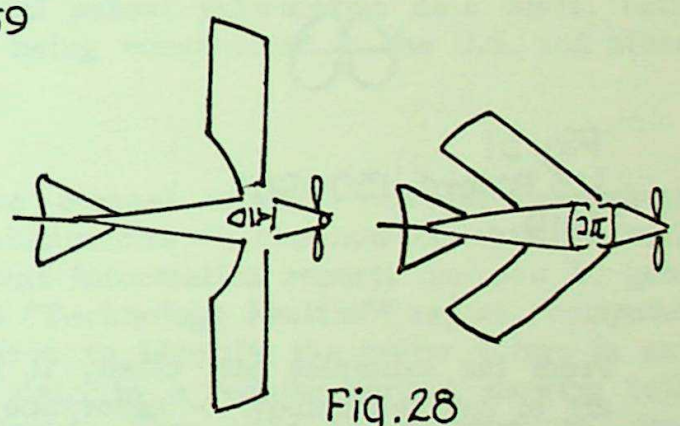


Fig. 28
U.S. Patent 1740016
1929

Those interested in the oblique-wing configuration developed by Jones (Figs. 29 and 30) for NASA should perhaps review the 1919 patent to Nicholas Rippenbeing of New Jersey (Fig. 31). Incidentally, the dual fuselage arrangement of one of Jones' patents likewise turns up in a 1919 Glenn Curtiss patent (Fig. 32).

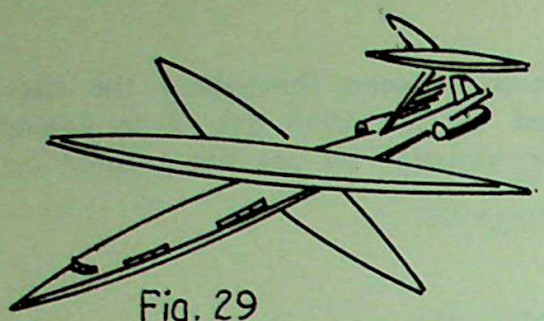


Fig. 29
U.S. Patent 3971535
1976

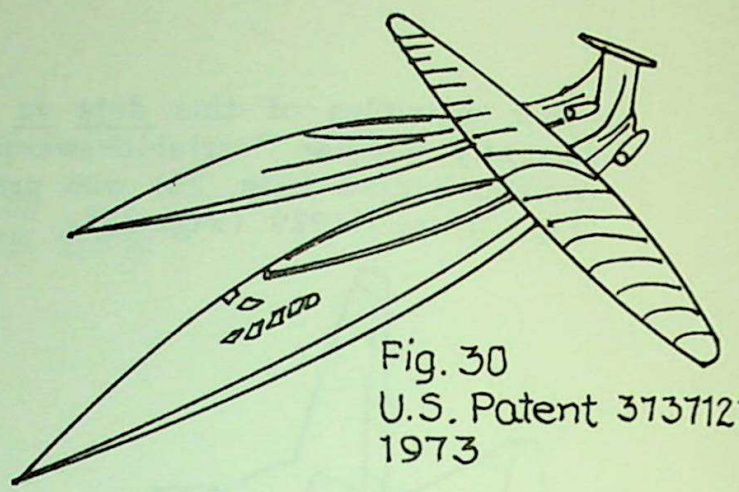


Fig. 30
U.S. Patent 3737121
1973

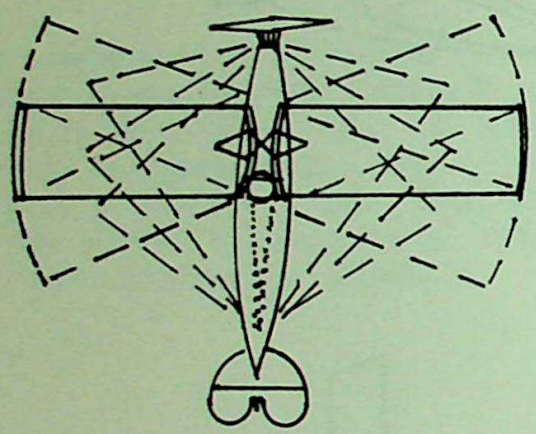


Fig. 31
U.S. Patent 1309961
1919

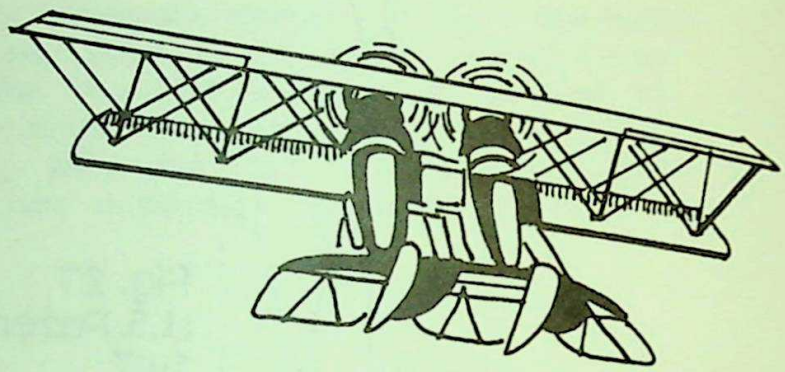


Fig. 32
U.S. Patent 1294412
1919

From the examples just cited, it is clear that an assessment of the state-of-the-art in any technology -- aerospace or otherwise -- should not overlook those earlier developments which lie dormant in the background, awaiting supportive or "enabling" breakthroughs, such as the development of new, stronger materials or an ingenious design change. Successful technological innovation depends as much upon intelligent application of information about past developments as upon new inventive efforts. Researchers, especially those involved in new product/process design, would be well advised to keep abreast of the patent literature in their respective fields. They just might find that many of their current difficulties were faced and resolved years before.

Patent literature, by the way, is not limited in definition to texts of invention disclosures. To the contrary, each document is filled with additional useful information -- data relating to such items as inventor and assignee identification, dates of grant and application, field of classification and search, and invention title and abstract. This additional information, conveyed in the multitude of patent grants, gives rise to the third principal case for the value of the patent file as a bibliographic data source.

CASE III
THE PATENT FILE:
A BIBLIOGRAPHIC DATA SOURCE

A Look at the Data

We have explored the patent file as a valuable resource of historic information, as well as an aid for current problem-solving. The textbook-like substantive content of this multitude of technical documents is impressive. An equally impressive aspect of the patent file is the unique information available through manipulation of the bibliographic data which accompany the patents flowing into the file.

Reports generated by automated data processing of patent information have enabled research analysts to "step back" and view patenting in the aggregate -- to study the inventing process as a whole and to assess trends, domestic and foreign, which perhaps reflect innovative spirit, industrial strength, and national economic health. The Office of Technology Assessment and Forecast (OTAF), among a number of diverse duties, regularly prepares such reports based upon its large data base (see Appendix C for details). Other computerized patent information data bases, both commercial and governmental, exist or are being constructed in the U.S. and other countries.

Consequently, what once required extensive manual effort -- weeks or perhaps months searching through stacks of patent documents -- can now be obtained with relative ease. Any of a wide range of patent information reports can now be generated by computer. For example, a special "Technology Profile"* report, computer prepared from the OTAF data base, can serve to identify the major actors in any patent technology, presenting bibliographic data in a tabular format showing both numeric counts and timing of patenting activity. Through a similar approach, patenting by selected corporations can be reviewed to reveal the technical focus of research and development.*

Possible Pitfalls

It should be noted that while this "numbers" approach to patent information can be extremely useful in inventive activity research, its use is not free of pitfalls. Reliance upon patent "output data" alone as wholly indicative of the character of a particular technology or industry may be imprudent. There are a number of factors which should be recognized.

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*Excerpts from sample OTAF special reports are included in Appendix C.

First and most obvious of these is the variance between patents in importance and degree of invention. Patent grants can seldom be assigned the same weight. Another significantly influential factor, especially for such a sensitive technology as Aerospace, is the necessity for national security -- occasionally a reason for the non-grant of patents.

Then, too, there is the question of the inventor's "propensity to patent" which may depend almost entirely upon economic conditions. In this context, it is widely felt that Government's role in R&D, especially in a field such as Aerospace, frequently influences corporate attitudes concerning patenting -- perhaps discouraging the investment of time and expense in patenting by effectively negating any prospective proprietary advantage. Another important factor for consideration is the development of intellectual property "protection" forms which are, in effect, alternatives to the patent process. Trade secrets, black-box techniques, and market leadtime are among the alternatives sometimes selected.

In "assessing" a technology from a patent activity standpoint, it is important to understand that conclusions drawn solely from an analysis of patent statistics may be affected by the noted factors. In other words, a sudden decline or rise in patent activity in a particular sector could be the result of any of a number of diverse circumstances - and may not simply reflect a decline or rise in inventive activity.

Do these pitfalls render patenting statistics useless as a research tool? Obviously, no.

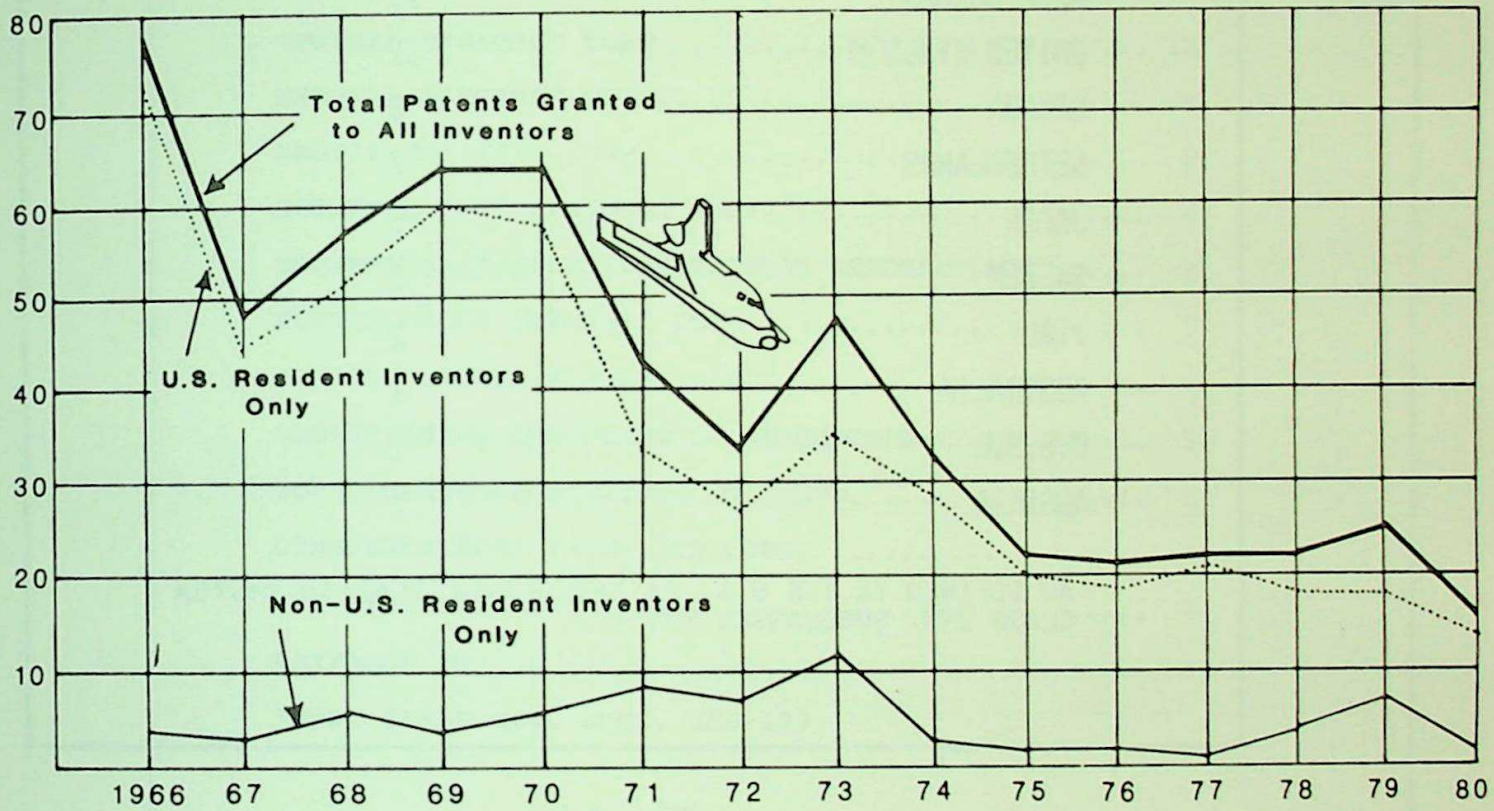
In the final analysis, it cannot be denied that each patent represents, to some degree, a new piece of technology and, inferentially, some increment of technological activity. Together, (in the hundreds, thousands, and tens-of-thousands), patents reveal the "who, where and what" about substantial amounts of new technologies and technological activities. Recent studies have shown that patent activity is often a good indicator of technological activity and economic performance. An example, again drawn from the Aerospace field, will serve to illustrate the form and usefulness of patent data as a research tool.

Spacecraft Patenting Trends

To demonstrate briefly the potential value of patent bibliographic information as a contribution to research, attention is again directed to the "Aeronautics" class. Focusing upon those sixteen subclasses which encompass "Spacecraft" technology, a computerized profile of recent patenting activity reveals a number of interesting facts. The following are highlights and a quick analysis of a "Technology Profile Report" on Class 244, subclasses 158-173.

As shown in Fig. 33, U.S. patenting activity in spacecraft technology has declined significantly since 1966. In fact, the decline is nearly 80% in the last 15 years. Interestingly, this decrease is not reflected in spacecraft technology patenting in the U.S. by foreign residents. This activity, although low, has remained fairly constant. In fact, at 20.6%, the foreign share of U.S. patenting for 1979-1980 is considerably below the all technology average of 38.5%.

U.S. PATENTING TRENDS IN SPACECRAFT TECHNOLOGY



(NOTE: AS DEFINED IN THE U.S. PATENT CLASSIFICATION SYSTEM, CLASS 244,SUBCLASSES 158-173)

Fig. 33

Of the 713 patent documents filed and cross-referenced in the subject subclasses since 1963, over half were corporate-owned at time of grant. In the most recent 3-year period, corporate share has increased to around 57%, again, less than the 75.8% all-technology average. U.S. Government R&D involvement, of course, has a large impact on these comparisons. During 1978-1980, Government ownership of all patent documents within the spacecraft subclass area of Aeronautics was over 33% -- nearly fourteen times the all-technology average.

NATIONAL ORIGIN OF SPACECRAFT PATENTING*

(1963-1980)

NATION (INVENTORS RESIDENCE)	NUMBER OF PATENTS GRANTED
UNITED STATES	639
FRANCE	20
WEST GERMANY	15
UNITED KINGDOM	12
CANADA	8
NETHERLANDS	7
JAPAN	5
SWEDEN	2
ITALY	2
AUSTRALIA	1
U.S.S.R	1
AUSTRIA	1

*AS DEFINED IN THE U.S. PATENT CLASSIFICATION SYSTEM CLASS 244, SUBCLASSES 158-173

Fig. 34

A look at the national and corporate actors in Fig. 34 shows that residents of eleven non-U.S. nations received spacecraft patents since 1963. Most patent-active were those inventors from France, West Germany and the United Kingdom.

Of 90 corporations and organizations, both international and domestic, to which 373 spacecraft patents were listed as assigned during the period 1969-1980, just ten businesses (RCA, TRW, Hughes Aircraft, General Dynamics, General Electric, Martin-Marietta, Rockwell International, Societe Nationale Industrielle Aerospatiale, Westinghouse, and British Aircraft) received more than one-third of that total. Only three organizations shared another third. Those organizations were agencies of the U.S. Government: NASA and the Departments of the Navy and Air Force. See Fig. 35.

ASSIGNED PATENTING

IN SPACECRAFT TECHNOLOGY*

(1969-1980)

ASSIGNEES HOLDING FOUR OR MORE PATENTS	TOTAL PATENTS HELD
USA/NASA	78
USA/NAVY	31
RCA CORP.	27
TRW, INC.	20
HUGHES AIRCRAFT CO.	19
USA/AIR FORCE	16
GENERAL DYNAMICS CORP.	12
GENERAL ELECTRIC CO.	9
MARTIN-MARIETTA CORP.	8
ROCKWELL INTERNATIONAL CORP.	8
SOCIETE NATIONALE INDUSTRIELLE AEROSPATIALE	8
WESTINGHOUSE ELECTRIC CORP.	7
BRITISH AIRCRAFT CORP., LTD.	6
ORGANIZATION EUROPEENE DE RECHERCHES SPATIALES	5
TOKYO SHIBAURA ELECTRIC CO., LTD.	5
COMMUNICATIONS SATELLITE CORP.	4
LTV AEROSPACE CORP.	4
RAYTHEON CO.	4

*USPC CLASS 244, SUBS. 158-173

Fig. 35

A full Technology Profile Report of the type suggested here will reveal the names of all nations and every corporation or organization involved in spacecraft patenting and the extent and timing of their involvement. Such a profile can be considerably expanded by the inclusion of specific patent numbers and invention titles associated with each corporation.

As noted above, other computerized approaches to the bibliographic data can be taken to further explore the patenting activity of a selected organization or corporation. For example, in an OTAF "Organizational Profile," patenting activity during the period spanning 1969-1980 can be tabulated by category of the USPC. Excerpts from an "Organizational Profile" for Boeing Company are shown in Fig. 36. The data-base listed more than 800 patents assigned, at time of grant, to Boeing Company during the 1969-1980 period.

PATENT CLASSIFICATION DISTRIBUTION
FOR BOEING COMPANY -- 1969-1980

Class	Title	% of all Boeing Patenting
29	Metal Working	2.1
33	Geometrical Instruments	1.3
60	Power Plants	4.0
72	Metal Deforming	3.2
73	Measuring & Testing	4.9
74	Machine Elements & Mechnanisms	2.0
114	Ships	2.7
137	Fluid Handling	1.5
156	Adhesive Bonding & Misc. Manufacture	2.5
181	Acoustics	1.6
204	Chemistry, Electrical & Wave Energy	1.3
219	Electric Heating	.9
239	Fluid Sprinkling, Spraying and Diffusing	1.7
244	Aeronautics	22.8
303	Fluid Pressure Brake & Analogous Systems	1.6
307	Electrical Transmission or Interconnected Systems	1.0
324	Electricity, Measuring & Testing	1.5
340	Communications, Electrical	1.7
343	Communications, Radio Wave	2.3
56	Optics, Measuring & Testing	1.2
364	Electrical Computers & Data Processing Systems	2.0
410	Freight Accommodation on Freight Carrier	1.3
416	Fluid Reaction Surfaces (i.e., Inpellers)	1.5
428	Stock Material or Misc. Articles	1.7
103 other classes		31.7

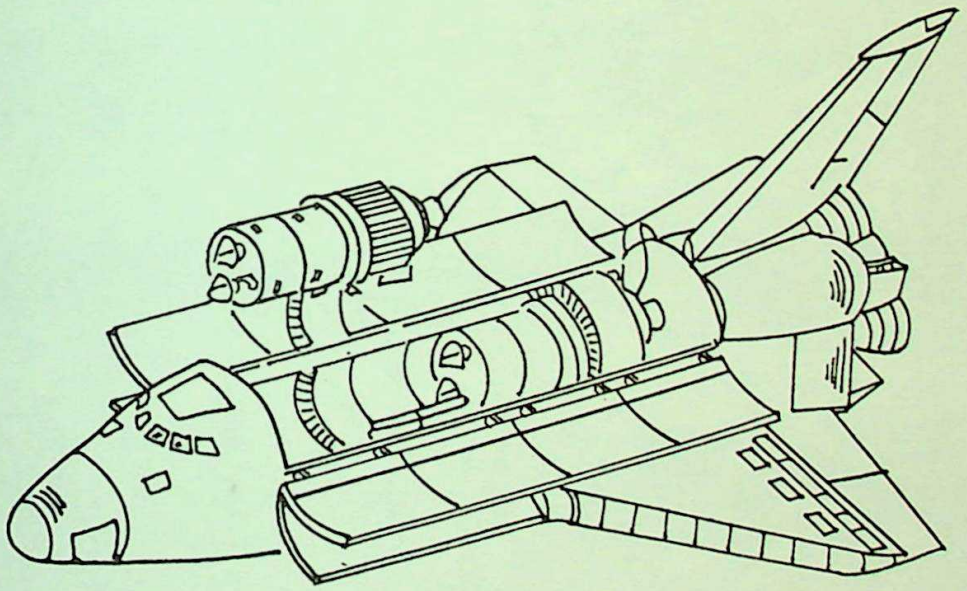
Fig. 36

It is interesting to note that Boeing, one of the most patent-active aerospace corporations, has received less than one-forth of its patents (1969-1980) in the "Aeronautics" Class 244 -- the patents being mainly concentrated in subclass areas related to "Aircraft Sustentation" and "Aircraft Control." The other patents are

spread amongst more than one hundred of the U.S. Patent Classes. While many of these may be related to the aircraft industry (Metal Working, Geometrical Instruments, Power Plants, Metal Deforming, Measuring and Testing, Fluid Pressure Brakes, and Communications) others range from Buckles to Ships, and Plant Husbandry to Railways, indicating a diversified technical effort.

CONCLUSION

We have discussed three examples of the use of the patent file as a tool in research efforts: As a comprehensive historical journal, as an aid in current R&D problem-solving efforts, and as a source of bibliographic data uniquely useful in trend and market analyses or assessment studies. As demonstrated in the "Aerospace" context, but true of any technical field, patent literature greatly enriches the universe of information which is critical not only to the inventive process, but also to educational and decision-making processes.



TECHNOLOGY ASSESSMENT & FORECAST

APPENDICES

The Patent System added the fuel of interest to the fire of genius.

A Lincoln

APPENDIX A

Appendix A1: Data Tables (Section II)

Patent Activity Tables 103

Show patent activity (1969-1980) by date of patent grant for each of the 10 foreign multinational corporations examined in Section II.

Technology Trend Tables 114

Illustrate patent activity, in selected technology classes, of the 10 foreign multinational corporations included in the study.

Appendix A2: Additional Policy, Legal Decisions and Citations (Section III)

Part 1 126

Reviews policy issues and court decisions in the field of software related technologies for the period 1964-1980.

Part 2 139

Contains citations and notes referred to in Section III and in appendix A2 - Part 1.

Part 3 152

Contains the section in the Manual of Patent Examining Procedure (M.P.E.P.), which relates to software patentability.

APPENDIX A1

Patent Activity Tables in this appendix show for each of the 10 Foreign Multinational Corporations (10FMNC) examined in Section II, the number of U.S. patents granted from 1969-1980.

The data are presented in several ways:

- Total
- U.S. Origin -- first listed inventor is a U.S. resident
- Foreign Origin -- first listed inventor is a foreign resident

The foreign origin data are further subdivided by country of inventor residence. Data breakdown based on patent ownership is also given both for the U.S. origin and foreign origin patents.

Categories of ownership which appear in the study have the following meanings:

- U.S. Corporate Owned -- the assignee is a U.S. corporation which is a subsidiary or affiliate of the foreign multinational corporation

- Foreign Owned, U.S. Origin -- the inventor is a U.S. resident and the assignee is a foreign corporation or foreign government

- U.S. Owned, Foreign Origin -- the inventor is foreign resident and the assignee is a U.S. corporation

- Foreign Corporate Owned -- the assignee is a foreign corporation

- Foreign Government Owned -- the assignee is a foreign government

Note that because many foreign corporations are nationalized, subsidiaries and/or affiliates can be foreign government organizations. The term "corporation" as used in these tables means any assignee other than a government agency or individual.

The second set of tables -- Patents Granted-By Class By Year -- show yearly activity in selected technologies as identified by classes within the U.S. Patent Classification System. Activity is shown for the 10FMNC combined, for the five Japanese firms combined, and for each individual firm. The classes selected were those where either the 10 firms collectively or the five Japanese firms collectively obtained 1% or more of their patents. Table A-1 shows the class numbers and descriptions which are included in this Appendix.

TABLE A-1

SELECTED CLASS NUMBERS AND DESCRIPTIONS

008 - Bleaching & dyeing of textiles & fibers
029 - Metal working
148 - Metal treatment
156 - Adhesive bonding and miscellaneous chemical manufacture
179 - Telephony
204 - Electrical and wave energy chemistry
219 - Electric heating
242 - Winding and reeling
250 - Radient energy
252 - Compositions
260 - Organic chemistry
307 - Electrical transmission systems
310 - Electrical generator or motor structure
313 - Electric lamp and discharge devices
315 - Electric lamp and discharge devices, systems
318 - Electricity, motive power systems
330 - Amplifiers
331 - Oscillators
340 - Electrical communications
350 - Optics, systems and elements
354 - Photography
357 - Active solid state devices, e.g., transistors
358 - Television
360 - Dynamic magnetic information storage or retrieval
361 - Electrical systems and devices
364 - Computers and data processing systems
365 - Static information storage and retrieval
424 - Drug, bioaffecting and body treating compositions
427 - Coating processes
428 - Stock material or miscellaneous articles
430 - Photographic chemistry
455 - Telecommunications
525,528 - Parts of the 520 Series directed to synthetic resins
544,546,548 - Parts of the 530-570 Series directed to organic chemistry

PATENT ACTIVITY (1/63-12/80) BY DATE OF PATENT GRANT

	NUMBER OF PATENTS														
	63-66	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL				2031	2243	2766	3290	3230	3462	3646	4073	3678	3579	2720	3381	38099
U.S. ORIGIN				226	264	265	328	244	233	262	294	269	283	165	221	3054
FOREIGN ORIGIN				1805	1979	2501	2962	2986	3229	3384	3779	3409	3296	2555	3160	35045
WEST GERMANY				878	779	975	1220	1168	1251	1392	1645	1452	1388	1099	1274	14521
JAPAN				343	503	785	893	917	1023	1128	1181	1095	1169	899	1215	11151
SWITZERLAND				215	248	199	322	285	319	343	342	305	233	202	237	3250
NETHERLANDS				193	228	265	220	306	302	244	295	281	239	190	229	2992
UNITED KINGDOM				61	77	76	87	99	86	98	91	82	89	56	66	968
FRANCE				54	53	76	78	86	100	82	106	68	83	49	68	903
BELGIUM				36	51	91	92	79	84	51	67	66	46	25	34	722
AUSTRIA				10	14	10	14	9	19	17	15	24	11	11	14	168
SWEDEN				5	8	8	8	12	15	12	20	18	16	14	9	145
INDIA				4	4	3	7	4	1	1	5	2	6	3	1	41
ITALY				2	2	3	1	3	4	1	3	5	7	3	4	38
AUSTRALIA				1	4	2	2	2	6	4	2	2	2		2	29
CANADA				1		3	3	2	1	1	3	1		1	3	19
DENMARK				1		2	5	1	2					1	1	13
MEXICO						1		4	2	3	1					11
SPAIN					3					1	2	2	1			9
INDONESIA				1		2	5									8
ISRAEL						1	1	2	1					2	1	8
SINGAPORE				1		1					2	1				5
FINLAND				1				3								4
S. AFRICA											1	2			1	4
GREECE			1	1												3
ICELAND				1	1											2
IRELAND					1		1									2
GUATAMELA					1		1									2
U.S.S.R.											1	1				2
BRAZIL								1			1					2
WEST INDIES								2								2
NORWAY				1							1					2
MORROCO				2												2
NEW ZEALAND				1			1									2
NIGERIA										1						1
JORDAN													1			1
SOUTH KOREA															1	1
PAKISTAN								1								1
OTHER CNTRIES (11)	1	1	1	1	3	3						1				11
U.S. ORIGIN	226	264	265	328	244	233	262	294	269	283	165	221	3054			
U.S. CORP. OWNED	213	251	254	310	229	223	246	277	254	262	157	204	2880			
U.S. GOVT. OWNED																
U.S. INDIV. OWNED																
FOREIGN OWNED	13	13	11	18	15	10	16	17	15	21	8	17	174			
FOREIGN ORIGIN	1805	1979	2501	2962	2986	3229	3384	3779	3409	3296	2555	3160	35045			
U.S. OWNED	410	508	540	512	570	637	657	803	728	636	509	600	7110			
FOREIGN OWNED	1395	1471	1961	2450	2416	2592	2727	2976	2681	2660	2046	2560	27935			
FOREIGN CORP.	1395	1471	1961	2449	2416	2591	2726	2976	2681	2659	2044	2560	27929			
FOREIGN GOVT.				1		1	1			1	2		6			
FOREIGN INDIV.																

OTAF SPECIAL REPORT - BAYER AG.

PATENT ACTIVITY (1/63-12/80) BY DATE OF PATENT GRANT

	NUMBER OF PATENTS													
	63-66	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL				434	438	559	721	638	657	641	740	681	651	501	628	7289
U.S. ORIGIN				57	54	45	56	38	40	39	36	40	65	34	68	572
FOREIGN ORIGIN				377	384	514	665	600	617	602	704	641	586	467	560	6717
WEST GERMANY				337	330	422	564	497	500	532	629	570	540	438	526	5885
BELGIUM				34	47	82	86	77	78	46	61	58	39	22	27	657
JAPAN				1		1	10	13	23	13	9	8	2	4	1	85
UNITED KINGDOM				3	3	2	2	5	5	5	2	2	1		3	33
FRANCE				2	1		1	2	3							9
MEXICO						1		4	2	2						9
SPAIN					2					1		2	1			6
ISRAEL									1	2				2	1	6
ITALY						1		1			1		1	1	1	6
SWITZERLAND						2	1								1	4
SWEDEN									1	1	1					3
DENMARK									2							2
NETHERLANDS					1	1										2
JORDAN													1			1
AUSTRALIA											1					1
GREECE						1										1
BULGARIA								1								1
COLUMBIA							1									1
AUSTRIA									1							1
BRAZIL												1				1
S. AFRICA													1			1
YUGOSLAVIA									1							1
INDIA						1										1
U.S. ORIGIN		57	54	45	56	38	40	39	36	40	65	34	68	572		
U.S. CORP. OWNED		56	51	45	52	37	38	35	31	35	56	33	60	529		
U.S. GOVT. OWNED																
U.S. INDIV. OWNED																
FOREIGN OWNED		1	3		4	1	2	4	5	5	9	1	8	43		
FOREIGN ORIGIN		377	384	514	665	600	617	602	704	641	586	467	560	6717		
U.S. OWNED		7	7	10	6	13	5	10	5	3	1	3	3	73		
FOREIGN OWNED		370	377	504	659	587	612	592	699	638	585	464	557	6644		
FOREIGN CORP.		370	377	504	659	587	612	592	699	638	584	464	557	6643		
FOREIGN GOVT.											1			1		
FOREIGN INDIV.																

OTAF SPECIAL REPORT - CIBA-GEIGY AG.

PATENT ACTIVITY (1/63-12/80) BY DATE OF PATENT GRANT

	NUMBER OF PATENTS														
	63-66	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL				319	368	333	553	465	469	520	568	477	447	318	394	5231
U.S. ORIGIN				77	94	91	161	116	86	116	147	113	124	74	83	1282
FOREIGN ORIGIN				242	274	242	392	349	383	404	421	364	323	244	311	3949
SWITZERLAND				207	241	191	314	275	307	335	332	297	222	192	230	3143
UNITED KINGDOM				17	19	30	41	45	42	37	38	42	59	30	36	436
WEST GERMANY				6	5	5	9	9	16	23	32	14	22	17	33	191
FRANCE				4	3	8	8	5	5	3	12	6	8	1	7	70
INDIA				4	4	2	7	4	1	1	4	2	4	2	1	36
SWEDEN				1	1	2	2	4	3	1		1				15
AUSTRIA				1		1	1	1	6	1	1			1		13
DENMARK				1		1	5	1						1	1	10
ITALY				1				1	1			1	4		1	9
AUSTRALIA					1	1			1	1			2			6
JAPAN						1	4						1			6
CANADA										1					2	3
BELGIUM							1	1								2
MEXICO										1	1					2
NETHERLANDS								2								1
SPAIN											1					1
NORWAY												1				1
MALAYSIA													1			1
NEW ZEALAND									1							1
TUNISIA								1								1
U.S. ORIGIN	77	94	91	161	116	86	116	147	113	124	74	83	1282			
U.S. CORP. OWNED	75	91	91	156	113	86	109	141	110	124	74	83	1253			
U.S. GOVT. OWNED																
U.S. INDIV. OWNED																
FOREIGN OWNED	2	3		5	3		7	6	3				29			
FOREIGN ORIGIN	242	274	242	392	349	383	404	421	364	323	244	311	3949			
U.S. OWNED	92	131	91	149	115	178	247	321	294	261	202	268	2349			
FOREIGN OWNED	150	143	151	243	234	205	157	100	70	62	42	43	1600			
FOREIGN CORP.	150	143	151	243	234	205	157	100	70	62	42	43	1600			
FOREIGN GOVT.																
FOREIGN INDIV.																

PATENT ACTIVITY (1/63-12/80) BY DATE OF PATENT GRANT

	NUMBER OF PATENTS														
	63-66	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL				47	87	132	159	168	208	199	224	184	209	142	169	1928
U.S. ORIGIN				2		1	1		1			1				6
FOREIGN ORIGIN				45	87	131	158	168	207	199	224	183	209	142	169	1922
JAPAN				45	87	130	156	168	206	199	224	183	209	142	169	1918
ITALY						1										1
ICELAND							1									1
CANADA							1									1
WEST INDIES									1							1
U.S. ORIGIN				2		1	1		1			1				6
U.S. CORP. OWNED				1												1
U.S. GOVT. OWNED																
U.S. INDIV. OWNED				1		1	1		1			1				5
FOREIGN OWNED																
FOREIGN ORIGIN				45	87	131	158	168	207	199	224	183	209	142	169	1922
U.S. OWNED					1		1	1			3					6
FOREIGN OWNED				45	86	131	157	167	207	199	221	183	209	142	169	1916
FOREIGN CORP.				45	86	131	157	167	207	199	221	183	209	142	169	1916
FOREIGN GOVT.																
FOREIGN INDIV.																

OTAF SPECIAL REPORT - HITACHI LTD.

PATENT ACTIVITY (1/63-12/80) BY DATE OF PATENT GRANT

	NUMBER OF PATENTS														
	63-66	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL				99	114	207	217	229	341	398	380	393	440	342	431	3591
U.S. ORIGIN					1	1		1	1			3	1	4	3	15
FOREIGN ORIGIN				99	113	206	217	228	340	398	380	390	439	338	428	3576
JAPAN				99	111	206	217	227	339	397	380	390	439	338	428	3571
UNITED KINGDOM					1					1						2
ISRAEL								1								1
WEST INDIES									1							1
ITALY					1											1
U.S. ORIGIN					1	1		1	1			3	1	4	3	15
U.S. CORP. OWNED					1											1
U.S. GOVT. OWNED																
U.S. INDIV. OWNED																
FOREIGN OWNED						1		1	1			3	1	4	3	14
FOREIGN ORIGIN				99	113	206	217	228	340	398	380	390	439	338	428	3576
U.S. OWNED				4	3	3	2		3	4	2	1	1		3	26
FOREIGN OWNED				95	110	203	215	228	337	394	378	389	438	338	425	3550
FOREIGN CORP.				95	110	203	215	228	337	394	378	389	438	338	425	3550
FOREIGN GOVT.																
FOREIGN INDIV.																

OTAF SPECIAL REPORT - HOECHST AG.

PATENT ACTIVITY (1/63-12/80) BY DATE OF PATENT GRANT

	NUMBER OF PATENTS													
	63-66	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL				254	216	254	365	281	316	401	485	396	411	313	356	4048
U.S. ORIGIN				11	23	20	18	14	15	21	27	28	25	20	24	246
FOREIGN ORIGIN				243	193	234	347	267	301	380	458	368	386	293	332	3802
WEST GERMANY				214	169	210	302	221	244	327	402	324	343	257	277	3290
FRANCE				27	21	21	37	42	50	45	48	32	37	25	41	426
AUSTRIA				1	2	1	5	2	2	4	3	5	2	6	7	40
UNITED KINGDOM				1	1	2	1		2	1	2	3	1	3	4	21
ITALY							1	1			1	1	1	1	1	7
INDIA											1		2	1		4
AUSTRALIA								1				1			1	3
BELGIUM									1	1		1				3
NETHERLANDS										1		1				2
SWITZERLAND										1						1
FINLAND							1									1
HAITI									1							1
SOUTH KOREA											1				1	1
SPAIN									1							1
BRAZIL																
U.S. ORIGIN				11	23	20	18	14	15	21	27	28	25	20	24	246
U.S. CORP. OWNED				7	22	18	17	13	14	19	27	26	25	18	22	228
U.S. GOVT. OWNED																
U.S. INDIV. OWNED																
FOREIGN OWNED				4	1	2	1	1	1	2		2		2	2	18
FOREIGN ORIGIN				243	193	234	347	267	301	380	458	368	386	293	332	3802
U.S. OWNED				2						1	1		2	1		7
FOREIGN OWNED				241	193	234	347	267	301	379	457	368	384	292	332	3795
FOREIGN CORP.				241	193	234	347	267	301	378	457	368	384	291	332	3793
FOREIGN GOVT.										1				1		2
FOREIGN INDIV.																

OTAF SPECIAL REPORT - MATSUSHITA ELECTRIC INDUSTRIAL CO. LTD

PATENT ACTIVITY (1/63-12/80) BY DATE OF PATENT GRANT

NUMBER OF PATENTS

	63-66	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL				114	188	246	272	283	278	284	276	239	206	131	192	2709
U.S. ORIGIN				2	1	4	5	6	5	8	18	8	3		3	63
FOREIGN ORIGIN				112	187	242	267	277	273	276	258	231	203	131	189	2646
JAPAN				110	184	242	266	276	272	275	257	231	203	131	189	2636
WEST GERMANY				1	2		1		1	1	1					7
FRANCE								1								1
ICELAND					1											1
ITALY				1												1
U.S. ORIGIN				2	1	4	5	6	5	8	18	8	3		3	63
U.S. CORP. OWNED						1	3		3	7	13	8	3		3	41
U.S. GOVT. OWNED																
U.S. INDIV. OWNED																
FOREIGN OWNED				2	1	3	2	6	2	1	5					22
FOREIGN ORIGIN				112	187	242	267	277	273	276	258	231	203	131	189	2646
U.S. OWNED				1	3	3	1	2	1	2			1	2	1	17
FOREIGN OWNED				111	184	239	266	275	272	274	258	231	202	129	188	2629
FOREIGN CORP.				111	184	239	266	275	272	274	258	231	202	129	188	2629
FOREIGN GOVT.																
FOREIGN INDIV.																

OTAF SPECIAL REPORT - PHILIPS GLOEILAMPENFABRIEKEN

PATENT ACTIVITY (1/63-12/80) BY DATE OF PATENT GRANT

	NUMBER OF PATENTS														
	63-66	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL				394	471	540	445	521	560	482	550	511	436	339	362	5611
U.S. ORIGIN				73	84	96	80	63	80	75	63	74	52	30	31	801
FOREIGN ORIGIN				321	387	444	365	458	480	407	487	437	384	309	331	4810
NETHERLANDS				193	226	264	219	304	302	243	295	280	239	190	229	2984
WEST GERMANY				48	49	59	40	46	62	49	63	63	53	50	35	617
UNITED KINGDOM				39	50	42	43	49	35	54	48	35	28	23	23	469
FRANCE				21	28	47	31	33	41	33	46	29	38	23	20	390
AUSTRIA				8	12	8	7	6	8	8	6	11	7	3	7	91
SWITZERLAND				5	4	4	7	9	8	6	8	4	9	9	5	78
SWEDEN				3	7	6	4	4	5	3	10	7	5	7	3	64
BELGIUM				2	2	9	5	1	5	3	6	2	4	2	4	45
AUSTRALIA				1	3	1	2	1	5	3	1	1			1	19
CANADA						1	2	2	1		2	1		1	1	11
ITALY					1	1			2	1	1	3	1	1		11
INDONESIA							1	2	5							8
JAPAN					1	1									3	5
FINLAND										3						3
MORROCO							2									2
ISRAEL											1					1
GREECE					1											1
GUATAMELA					1											1
KINSHASA					1											1
IRELAND								1								1
NORWAY							1									1
SPAIN					1											1
NEW ZEALAND							1									1
NIGERIA										1						1
CHILE				1								1				1
U.S.S.R.						1										1
DENMARK									1							1
PAKISTAN																1
U.S. ORIGIN				73	84	96	80	63	80	75	63	74	52	30	31	801
U.S. CORP. OWNED				73	83	94	79	63	80	75	63	74	52	30	31	797
U.S. GOVT. OWNED																
U.S. INDIV. OWNED																
FOREIGN OWNED					1	2	1									4
FOREIGN ORIGIN				321	387	444	365	458	480	407	487	437	384	309	331	4810
U.S. OWNED				299	355	420	343	428	447	386	466	419	359	286	314	4522
FOREIGN OWNED				22	32	24	22	30	33	21	21	18	25	23	17	288
FOREIGN CORP.				22	32	24	22	30	33	21	21	18	25	23	17	288
FOREIGN GOVT.																
FOREIGN INDIV.																

OTAF SPECIAL REPORT - SIEMENS AG.

PATENT ACTIVITY (1/63-12/80) BY DATE OF PATENT GRANT

	NUMBER OF PATENTS														
	63-66	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL				282	238	290	316	409	448	476	539	514	463	350	423	4748
U.S. ORIGIN				4	5	6	6	3	3	3	3	2	12	3	9	59
FOREIGN ORIGIN				278	233	284	310	406	445	473	536	512	451	347	414	4689
WEST GERMANY				272	224	279	304	395	428	460	518	481	430	337	403	4531
SWEDEN				1			2	4	6	7	9	10	11	7	5	62
SWITZERLAND				3	3	2		1	4	1	2	4	2	1	1	24
AUSTRIA							1		2	4	5	8	2	1		23
BELGIUM					2					1		5	3	1	3	15
FRANCE							1	3	1			1				6
UNITED KINGDOM				1	2				2		1					6
SINGAPORE								1				2	1			4
CANADA				1		2					1					4
S. AFRICA												1	1		1	3
ITALY									1						1	2
NETHERLANDS					1		1									2
GREECE							1									1
U.S.S.R.													1			1
HUNGARY						1										1
MALI									1							1
GUATAMELA								1								1
IRELAND					1											1
ARGENTINA								1								1
U.S. ORIGIN				4	5	6	6	3	3	3	3	2	12	3	9	59
U.S. CORP. OWNED				1	3	5	3	3	2	1	2	1	2	2	5	30
U.S. GOVT. OWNED																
U.S. INDIV. OWNED																
FOREIGN OWNED				3	2	1	3		1	2	1	1	10	1	4	29
FOREIGN ORIGIN				278	233	284	310	406	445	473	536	512	451	347	414	4689
U.S. OWNED				3	5	2	3	5	2			2	2			24
FOREIGN OWNED				275	228	282	307	401	443	473	536	510	449	347	414	4665
FOREIGN CORP.				275	228	282	306	401	442	473	536	510	449	346	414	4662
FOREIGN GOVT.							1		1					1		3
FOREIGN INDIV.																

OTAF SPECIAL REPORT - SONY CORP.

PATENT ACTIVITY (1/63-12/80) BY DATE OF PATENT GRANT

NUMBER OF PATENTS

	63-66	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL				29	40	81	80	96	103	148	213	170	133	122	163	1378
U.S. ORIGIN					1			2					1			4
FOREIGN ORIGIN				29	39	81	80	94	103	148	213	170	132	122	163	1374
JAPAN				29	39	81	79	94	103	147	213	170	132	122	162	1371
FRANCE										1						1
SWEDEN							1								1	1
SINGAPORE																1
U.S. ORIGIN					1			2					1			4
U.S. CORP. OWNED																
U.S. GOVT. OWNED																
U.S. INDIV. OWNED																
FOREIGN OWNED					1			2					1			4
FOREIGN ORIGIN				29	39	81	80	94	103	148	213	170	132	122	163	1374
U.S. OWNED				2	1	9	7	5		7	5	9	8	15	9	77
FOREIGN OWNED				27	38	72	73	89	103	141	208	161	124	107	154	1297
FOREIGN CORP.				27	38	72	73	89	103	141	208	161	124	107	154	1297
FOREIGN GOVT.																
FOREIGN INDIV.																

OTAF SPECIAL REPORT - TOSHIBA CORP.

PATENT ACTIVITY (1/63-12/80) BY DATE OF PATENT GRANT

	NUMBER OF PATENTS															
	63-66	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL				59	83	124	162	140	82	97	98	113	183	162	263	1566
U.S. ORIGIN					1	1	1	1	2							6
FOREIGN ORIGIN				59	82	123	161	139	80	97	98	113	183	162	263	1560
JAPAN				59	81	123	161	139	80	97	98	113	183	162	263	1559
UNITED KINGDOM					1											1
U.S. ORIGIN					1	1	1	1	2							6
U.S. CORP. OWNED																
U.S. GOVT. OWNED																
U.S. INDIV. OWNED																
FOREIGN OWNED					1	1	1	1	2							6
FOREIGN ORIGIN				59	82	123	161	139	80	97	98	113	183	162	263	1560
U.S. OWNED					2	2		1	1				1		2	9
FOREIGN OWNED				59	80	121	161	138	79	97	98	113	182	162	261	1551
FOREIGN CORP.				59	80	121	161	138	79	97	98	113	182	162	261	1551
FOREIGN GOVT.																
FOREIGN INDIV.																

10FMNCs

PATENTS GRANTED - BY CLASS BY YEAR

CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
008	36	41	42	53	40	49	52	84	55	93	26	53	624
029	31	35	43	48	54	65	61	36	47	45	38	37	540
148	14	27	30	44	40	40	55	60	45	32	28	29	444
156	25	18	39	48	38	35	25	34	29	42	22	34	389
179	24	42	26	32	31	42	57	65	79	66	50	57	571
204	36	32	30	46	38	51	39	42	49	51	39	42	495
219	18	29	34	28	32	34	22	38	31	34	29	44	373
242	12	15	30	23	25	30	36	19	23	20	17	26	276
250	45	45	66	61	67	88	76	91	80	107	81	102	909
252	36	50	51	98	60	57	54	72	64	70	48	51	711
260	234	234	216	381	285	331	391	423	359	345	231	274	3704
307	26	22	59	51	69	55	60	87	88	60	34	52	663
310	26	28	28	18	25	26	28	29	32	27	21	28	316
313	44	59	88	68	88	83	104	73	80	62	47	61	857
315	57	38	39	37	56	52	58	54	45	40	40	39	555
318	16	23	36	32	30	38	34	30	33	34	22	33	361
330	22	21	10	15	14	26	32	36	40	27	20	14	277
331	17	24	26	26	26	26	22	16	29	18	15	15	260
340	8	10	26	32	48	56	54	52	52	60	36	57	491
350	6	17	29	16	29	44	35	62	56	52	35	34	415
354	42	54	37	44	36	35	35	53	36	71	38	48	529
357	52	40	59	75	63	64	66	92	97	72	67	70	817
358	21	41	85	61	106	82	92	105	106	85	76	138	998
360	36	38	42	68	62	63	61	79	45	70	62	53	679
361	9	18	28	31	31	31	31	34	34	32	12	31	322
364	7	15	27	29	38	27	29	34	42	49	47	66	410
365	11	28	16	26	24	20	23	29	28	42	34	23	304
424	57	77	54	125	122	127	125	217	240	218	172	221	1755
427	26	35	37	52	25	42	37	31	27	47	26	33	418
428	21	39	36	37	29	35	52	56	45	50	48	49	497
430	95	97	244	252	231	226	185	202	192	147	123	163	2157
455	16	12	22	12	21	21	25	43	27	25	17	35	276
525	36	19	45	51	36	31	52	68	44	50	44	56	532
528	61	62	42	65	45	52	39	58	55	67	57	53	656
544	50	69	70	95	62	69	91	63	53	26	29	37	714
546	44	45	21	48	51	39	73	87	31	16	10	40	505
548	16	19	28	77	73	84	88	87	51	35	21	21	600
TOTAL	1333	1518	1841	2305	2150	2276	2399	2741	2469	2387	1762	2219	25400

5 JAPANESE FMNCs

PATENTS GRANTED - BY CLASS BY YEAR

CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
008	0	0	0	0	0	0	0	0	0	0	0	2	2
029	9	15	17	23	20	27	18	14	13	20	18	20	214
148	4	8	13	18	18	23	25	33	23	18	15	21	219
156	5	6	9	7	10	11	10	15	6	12	10	13	114
179	5	7	10	14	16	20	40	43	44	41	33	36	309
204	5	8	6	13	9	19	15	13	21	14	7	10	140
219	2	14	13	13	14	15	11	29	15	25	11	24	186
242	6	6	17	12	15	18	22	14	13	10	7	14	154
250	16	19	24	22	27	28	17	16	16	27	17	35	264
252	17	22	17	45	18	17	19	33	19	18	9	19	253
260	2	1	3	9	6	10	11	7	5	18	6	16	94
307	4	7	24	17	30	28	39	53	50	39	16	28	335
310	6	14	15	8	7	15	8	8	15	10	10	16	132
313	11	21	47	29	37	39	43	19	22	20	18	26	332
315	21	16	24	19	25	16	29	30	18	18	20	26	262
318	6	12	25	18	16	11	16	19	20	23	17	19	202
330	6	11	5	3	6	16	23	30	31	19	17	11	178
331	2	3	11	13	8	11	7	11	16	9	9	8	108
340	1	3	13	16	17	35	29	30	23	36	21	32	256
350	1	4	8	8	8	21	26	31	26	13	13	16	175
354	1	10	6	5	7	10	21	31	21	36	13	14	175
357	17	13	26	41	28	41	25	48	67	40	39	42	427
358	7	15	38	39	72	57	56	70	67	60	58	97	636
360	22	21	30	61	50	49	55	69	30	53	44	45	529
361	1	6	11	11	10	10	14	12	14	16	6	21	132
364	6	5	21	14	15	15	14	9	17	33	26	42	217
365	1	5	4	9	9	9	9	10	5	21	17	12	111
424	0	0	0	1	0	0	1	0	0	0	0	0	2
427	7	15	9	15	7	16	19	11	10	21	8	14	152
428	5	9	13	12	13	13	18	14	20	24	26	18	185
430	28	42	80	104	96	111	113	118	107	88	72	97	1056
455	5	5	11	7	8	12	16	31	22	16	12	27	172
525	3	1	2	2	3	0	4	8	8	7	6	4	48
528	1	1	1	5	3	1	2	4	1	5	1	4	29
544	0	0	0	1	0	0	0	0	0	2	0	0	3
546	0	0	0	0	0	0	0	3	1	0	0	1	5
548	1	0	0	2	0	4	2	2	0	0	1	1	13
TOTAL	234	345	553	636	628	728	777	888	786	812	603	831	7821

BAYER AG.

PATENTS GRANTED - BY CLASS BY YEAR

CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
008	16	11	23	9	13	12	10	17	12	16	2	10	151
029	0	0	0	3	0	1	2	2	1	0	0	3	12
156	2	4	4	5	5	5	2	3	8	7	3	7	55
179	0	2	0	0	0	1	0	0	0	0	0	0	3
204	8	4	11	7	4	8	11	5	5	5	6	8	82
219	0	2	2	1	0	0	0	1	2	0	1	0	9
242	5	5	9	6	5	7	9	0	4	5	7	6	68
250	1	0	5	5	7	6	3	7	5	6	10	6	61
252	1	4	6	11	12	11	7	14	12	11	10	8	107
260	65	81	70	124	92	117	132	149	128	102	80	94	1234
310	0	0	0	0	0	0	0	0	1	0	0	0	1
313	0	1	0	0	0	0	0	0	0	0	0	0	1
315	0	0	0	1	1	2	0	0	0	0	1	0	5
318	0	0	0	1	2	1	0	1	0	0	0	1	6
331	0	0	0	0	0	0	0	0	1	2	0	0	3
340	0	0	1	0	0	0	1	0	1	0	0	0	3
350	1	0	4	4	2	2	1	0	0	2	0	1	17
354	38	42	28	36	25	21	13	18	12	26	21	28	308
358	0	1	0	0	6	1	2	1	3	0	0	0	14
360	0	0	1	0	1	0	0	0	0	0	1	1	4
361	0	0	0	1	1	1	1	0	0	0	0	1	5
364	1	1	0	1	0	0	0	0	0	0	0	1	4
365	0	0	0	0	1	0	1	0	0	0	0	0	2
424	7	14	19	33	35	45	52	85	98	72	68	92	620
427	7	4	4	11	4	7	5	2	5	4	2	5	60
428	7	10	10	8	8	9	11	15	2	8	9	7	104
430	46	49	133	119	106	90	51	52	61	38	32	35	812
525	19	8	12	23	20	14	27	33	21	20	27	29	253
528	36	41	23	33	20	27	21	22	28	32	27	34	344
544	8	21	20	30	17	18	24	22	18	11	11	13	213
546	10	7	6	13	17	10	26	34	11	5	2	9	150
548	3	7	10	30	39	42	27	40	23	15	10	8	254
TOTAL	281	319	401	515	443	458	439	523	462	387	330	407	4965

CIBA-GEIGY AG.

PATENTS GRANTED - BY CLASS BY YEAR

CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
008	12	21	7	29	14	16	17	30	22	42	14	15	239
029	0	0	0	1	0	0	1	0	2	1	0	0	5
148	0	0	0	0	0	0	0	1	2	0	0	0	3
156	0	0	2	4	2	4	2	2	1	3	0	2	22
204	2	2	2	3	3	3	1	1	0	6	4	5	32
219	0	0	0	0	0	0	0	0	0	1	0	0	1
242	0	2	0	1	0	0	0	1	1	0	0	1	6
250	0	2	2	2	0	1	1	0	1	0	0	0	9
252	4	6	7	16	7	5	12	7	12	16	15	8	115
260	91	95	73	153	120	132	154	162	130	133	78	94	1415
340	0	0	0	0	2	0	0	0	0	0	0	0	2
350	0	0	0	0	0	0	0	1	1	0	0	0	2
354	1	0	0	0	1	0	0	0	0	0	0	0	2
361	1	0	0	0	1	0	0	0	0	0	0	0	2
364	0	0	0	1	1	0	0	0	0	0	0	0	2
424	29	50	28	66	64	57	41	75	70	71	57	60	668
427	3	4	3	5	5	6	3	6	6	6	5	2	54
428	2	3	2	3	4	5	6	15	8	6	3	8	65
430	16	3	20	24	22	15	5	8	11	7	8	15	154
525	8	4	6	10	4	5	6	9	5	13	6	14	90
528	8	12	12	17	16	15	10	24	12	19	20	12	177
544	39	40	46	53	30	35	38	20	28	13	14	19	375
546	21	32	11	26	26	21	26	30	13	4	5	21	236
548	12	11	16	35	30	32	43	29	22	12	9	10	261
TOTAL	249	287	237	449	352	352	366	421	347	353	238	286	3937

FUJI PHOTO FILM CO. LTD.

PATENTS GRANTED - BY CLASS BY YEAR

CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
029	0	1	0	0	0	2	0	0	0	2	0	0	5
148	0	0	0	0	0	0	0	2	2	1	1	1	7
156	1	3	1	2	1	3	0	6	0	1	2	1	21
204	0	0	0	0	1	6	3	1	6	4	1	2	24
219	0	1	1	1	0	0	0	0	1	0	0	0	4
242	1	2	5	1	4	4	2	3	2	4	1	2	31
250	0	3	1	1	7	8	2	3	6	3	0	3	37
252	1	1	3	5	4	8	4	9	4	7	2	0	48
260	0	0	2	4	3	7	6	4	3	8	2	7	46
307	0	0	0	0	1	0	1	0	1	1	0	0	4
313	0	0	0	0	1	0	0	0	0	0	0	0	1
315	0	0	0	0	0	0	1	0	0	0	1	2	4
318	0	0	0	0	0	1	0	0	1	0	0	0	2
340	0	0	0	0	0	0	0	1	0	1	0	0	2
350	0	1	2	2	1	2	6	9	6	6	5	3	43
354	0	8	6	4	6	5	17	26	18	36	11	7	144
358	1	0	0	2	2	2	2	3	2	2	3	3	22
360	0	0	0	2	1	0	1	0	1	4	2	1	12
361	0	1	1	0	1	1	1	0	0	0	0	0	4
364	0	0	0	0	1	1	0	0	0	0	0	0	2
424	0	0	0	1	0	0	1	0	0	0	0	0	2
427	0	3	3	2	2	5	8	4	5	10	0	4	46
428	2	4	6	10	8	9	9	8	9	14	15	10	104
430	23	38	76	96	82	101	99	111	96	79	69	91	961
525	0	0	0	0	1	0	0	2	2	0	0	0	5
528	0	0	0	0	0	1	0	1	0	0	0	0	2
544	0	0	0	1	0	0	0	0	0	2	0	0	3
546	0	0	0	0	0	0	0	2	1	0	0	0	3
548	0	0	0	2	0	4	2	2	0	0	0	1	11
TOTAL	29	66	107	136	127	169	165	197	166	185	115	138	1600

HITACHI LTD.

PATENTS GRANTED - BY CLASS BY YEAR

CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
008	0	0	0	0	0	0	0	0	0	0	0	1	1
029	6	5	6	12	7	16	9	10	4	13	7	11	106
148	2	3	6	12	12	13	14	16	13	7	3	10	111
156	1	1	2	3	2	6	6	8	3	3	0	5	40
179	1	2	3	5	2	3	9	11	9	15	14	11	85
204	1	0	0	3	1	4	5	8	4	3	5	3	37
219	0	3	6	1	2	1	2	6	0	5	4	13	43
242	1	1	0	3	0	1	0	0	1	4	2	3	16
250	9	10	10	9	12	14	10	5	7	15	10	15	126
252	2	4	4	2	2	3	4	6	6	3	2	7	45
260	1	1	0	2	1	2	4	3	0	9	3	6	32
307	3	3	12	7	10	14	13	18	31	20	6	11	148
310	0	1	5	4	1	11	3	6	6	6	7	7	57
313	3	5	3	5	11	17	22	8	7	6	9	12	108
315	5	2	5	3	7	6	15	12	4	12	14	8	93
318	4	0	5	4	6	5	11	13	9	14	8	8	87
330	4	8	4	1	2	4	6	7	12	6	6	1	61
331	2	3	8	5	2	6	2	1	8	3	3	3	46
340	1	1	7	4	7	17	18	17	13	21	17	16	139
350	0	3	3	5	4	16	11	9	10	3	5	6	75
354	1	1	0	0	0	2	2	2	0	0	1	6	15
357	7	7	9	14	12	22	9	28	36	22	16	19	201
358	0	2	7	5	13	12	19	16	10	10	5	17	116
360	1	1	2	1	5	6	6	7	2	4	4	6	45
361	0	1	0	2	0	1	1	2	2	8	2	4	23
364	5	2	15	4	10	6	9	5	14	9	9	17	105
365	1	1	3	5	7	4	4	6	3	13	10	4	61
427	2	2	1	4	1	3	8	2	3	5	4	8	43
428	0	2	5	0	1	1	6	1	3	3	2	4	28
430	0	0	0	4	3	3	4	2	5	6	1	5	33
455	2	0	2	0	3	1	0	2	3	2	3	9	27
525	3	0	1	1	2	0	2	5	6	4	4	3	31
528	0	0	1	3	0	0	2	3	1	3	0	2	15
TOTAL	68	75	135	133	148	220	236	245	235	257	186	261	2199

HOECHST AG.

PATENTS GRANTED - BY CLASS BY YEAR

CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
008	8	9	12	15	13	21	24	35	18	30	9	25	219
029	0	0	0	1	1	0	0	0	0	0	2	0	4
148	1	1	1	3	1	0	0	3	0	0	0	0	10
156	1	0	2	2	1	1	3	1	1	2	1	1	16
204	11	7	3	10	6	5	5	9	7	7	4	11	85
219	3	3	3	3	4	4	0	0	5	0	3	3	31
242	0	1	0	0	0	0	0	0	3	1	1	0	6
250	1	3	1	1	0	0	3	1	0	1	3	2	16
252	4	6	8	11	11	12	9	12	11	15	12	11	122
260	67	48	68	91	62	67	91	100	90	85	65	64	898
307	0	0	0	0	0	0	1	0	0	0	0	0	1
318	0	0	0	0	0	2	0	0	1	0	0	1	4
340	0	0	0	0	0	1	0	0	0	0	0	0	1
350	0	0	1	0	0	0	0	1	1	2	0	0	5
354	0	0	0	0	0	1	0	3	3	7	3	4	21
358	0	0	0	0	0	0	0	0	0	1	0	2	3
361	0	0	0	0	0	0	0	1	1	0	0	0	2
364	0	1	0	0	0	1	0	1	0	0	2	0	5
424	15	6	4	17	18	21	26	52	69	69	44	67	408
427	1	2	4	5	2	2	3	2	1	8	2	3	35
428	2	8	7	9	3	2	10	4	4	8	5	10	72
430	0	0	0	0	0	1	9	16	7	5	10	12	60
455	0	0	0	0	0	0	0	0	0	0	0	1	1
525	6	6	25	16	9	12	15	18	10	10	5	9	141
528	14	6	6	10	6	8	6	8	13	9	9	3	98
544	3	8	4	10	14	16	28	20	7	0	4	5	119
546	13	6	3	9	8	8	20	20	6	7	3	9	112
548	0	1	2	9	3	6	16	15	6	5	1	2	66
TOTAL	150	122	154	222	162	191	269	322	264	272	188	245	2561

MATSUSHITA ELECTRIC INDUSTRIAL CO. LTD.

PATENTS GRANTED - BY CLASS BY YEAR

CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
029	3	4	6	7	8	6	5	2	3	3	3	6	56
148	1	3	2	2	1	6	7	9	4	6	5	5	51
156	1	2	2	2	2	1	4	1	0	5	0	2	22
179	1	3	3	6	9	13	18	19	23	16	9	14	134
204	4	7	5	7	5	9	5	2	4	1	1	2	52
219	0	10	6	8	5	12	6	21	13	16	6	6	109
242	3	1	8	6	6	9	7	4	5	1	2	1	53
250	4	4	9	7	4	4	5	1	0	5	2	2	47
252	11	16	10	26	11	4	9	18	8	7	4	6	130
260	0	0	1	1	0	0	0	0	1	1	0	1	5
307	1	3	4	5	5	4	9	9	6	2	1	1	50
310	4	11	3	1	5	4	4	1	6	1	2	4	46
313	2	5	10	4	10	12	11	2	3	5	1	2	67
315	4	3	16	4	11	6	4	6	4	1	3	5	67
318	1	6	11	9	2	2	1	2	7	2	5	7	55
330	2	1	0	0	2	6	0	1	0	3	2	1	18
331	0	0	2	6	6	2	3	3	3	0	1	3	29
340	0	1	4	1	5	7	5	4	5	4	1	3	40
350	1	0	2	1	2	1	8	12	8	1	1	3	40
354	0	0	0	0	0	2	2	2	1	0	1	0	8
357	6	3	9	12	11	10	6	3	3	3	3	4	73
358	1	3	12	14	31	22	18	27	27	14	13	24	206
360	14	16	19	36	25	29	33	24	14	28	10	12	260
361	1	4	7	6	4	6	7	6	7	2	2	4	56
364	0	0	5	3	1	3	2	0	0	2	0	0	16
365	0	1	1	3	1	1	0	1	0	1	1	1	11
427	4	9	3	4	1	5	2	4	2	2	0	0	36
428	1	3	2	2	2	3	2	2	3	3	6	2	31
430	3	4	3	3	8	5	6	4	4	3	0	1	44
455	2	5	7	3	2	8	8	14	8	2	3	6	68
525	0	0	0	1	0	0	1	1	0	0	0	0	3
528	0	1	0	0	0	0	0	0	0	0	1	0	2
546	0	0	0	0	0	0	0	1	0	0	0	1	2
548	0	0	0	0	0	0	0	0	0	0	1	0	1
TOTAL	75	129	172	190	185	202	198	206	172	140	90	129	1888

PHILIPS GLOEILAMPENFABRIEKEN

PATENTS GRANTED - BY CLASS BY YEAR

CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
008	0	0	0	0	0	0	1	2	3	5	1	1	13
029	10	13	18	10	15	26	14	11	14	12	9	6	158
148	2	6	11	14	16	12	19	17	8	8	6	6	125
156	3	2	7	13	9	6	5	5	9	9	5	7	80
179	7	16	10	11	3	15	11	16	20	13	12	12	146
204	7	6	4	5	8	9	4	8	5	9	9	2	76
219	6	6	9	3	7	9	6	6	4	7	10	9	82
242	1	1	3	3	3	5	3	3	2	3	1	5	33
250	18	15	23	16	15	25	24	26	20	28	18	19	247
252	7	8	10	8	9	8	1	4	5	7	2	3	72
260	8	9	2	3	5	4	3	5	6	7	1	5	58
307	16	12	24	21	28	17	9	14	21	10	8	12	192
310	7	7	5	5	3	5	4	3	3	3	2	2	49
313	27	26	33	29	39	25	47	46	51	37	25	30	415
315	25	17	13	12	26	29	25	17	20	18	14	13	229
318	6	5	6	7	2	4	2	7	5	5	0	4	53
330	10	7	3	11	6	8	6	3	7	3	2	1	67
331	14	17	9	8	9	8	9	4	7	2	2	3	92
340	4	5	9	8	21	12	13	12	12	14	10	12	132
350	2	13	16	4	8	11	5	10	12	16	3	7	107
354	1	2	2	2	2	3	0	0	0	2	1	1	16
357	17	17	25	25	23	16	33	36	14	12	19	9	246
358	14	25	46	22	27	21	30	33	29	20	17	33	317
360	11	17	9	7	10	13	4	9	13	15	14	7	129
361	4	5	7	3	6	9	3	5	6	2	3	2	55
364	0	6	5	5	16	5	4	15	15	7	10	11	99
365	5	17	5	10	3	7	8	12	9	13	4	7	100
424	6	7	3	8	5	4	5	5	3	6	3	2	57
427	2	6	7	9	2	4	2	4	2	2	3	5	48
428	1	6	1	1	0	4	3	2	1	1	4	5	29
430	5	3	10	3	3	5	5	5	3	5	1	4	52
455	8	7	11	4	10	8	6	9	3	5	2	5	78
528	1	2	0	0	0	1	0	0	1	0	0	0	5
544	0	0	0	1	1	0	1	1	0	0	0	0	4
546	0	0	1	0	0	0	1	0	0	0	0	0	2
548	0	0	0	1	1	0	0	1	0	2	0	0	5
TOTAL	255	311	347	292	341	338	316	356	333	308	221	250	3668

SIEMENS AG.

PATENTS GRANTED - BY CLASS BY YEAR

CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
029	12	7	8	10	18	11	26	9	17	12	9	8	147
148	7	12	5	9	5	5	11	6	12	6	7	2	87
156	14	6	15	17	11	8	3	8	4	9	3	4	102
179	12	17	6	7	12	6	6	6	15	12	5	9	113
204	3	5	4	8	8	7	3	6	11	10	9	6	80
219	7	4	7	8	7	6	5	2	5	1	4	8	64
242	0	0	1	1	2	0	2	1	0	1	1	0	9
250	9	6	11	15	18	28	28	41	38	45	33	40	312
252	3	4	3	7	3	4	6	2	5	3	0	2	42
260	1	0	0	1	0	1	0	0	0	0	1	1	5
307	6	3	11	13	11	10	11	20	17	11	10	12	135
310	13	7	8	5	15	6	16	18	13	14	9	10	134
313	6	11	8	10	12	19	14	8	7	5	4	5	109
315	11	5	2	5	4	5	4	7	7	4	5	0	59
318	4	6	5	6	10	20	16	3	7	6	5	8	96
330	6	3	2	1	2	2	3	3	2	5	1	2	32
331	1	4	6	5	9	7	6	1	5	5	4	4	57
340	3	2	3	8	8	8	11	10	16	10	5	13	97
350	2	0	0	0	11	10	3	19	16	19	19	10	109
354	1	0	1	1	1	0	1	1	0	0	0	1	7
357	18	10	8	9	12	7	8	8	16	20	9	19	144
358	0	0	1	0	1	3	4	1	7	4	1	6	28
360	3	0	2	0	1	1	2	1	2	2	3	0	17
361	3	7	10	16	13	11	13	16	13	14	3	7	126
364	0	2	1	8	6	6	11	9	10	9	9	12	83
365	5	6	7	7	11	4	5	7	14	8	13	4	91
427	6	4	10	7	5	7	5	6	3	6	6	4	69
428	4	3	3	4	1	2	4	6	10	3	1	1	42
430	0	0	1	2	4	4	2	3	3	4	0	0	23
455	3	0	0	1	3	1	3	3	2	4	3	2	25
528	1	0	0	0	0	0	0	0	0	2	0	0	3
548	0	0	0	0	0	0	0	0	0	1	0	0	1
TOTAL	164	134	149	191	224	209	232	231	277	255	182	200	2448

SONY CORP.

PATENTS GRANTED - BY CLASS BY YEAR

CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
029	0	1	3	0	3	2	1	1	3	2	2	0	18
148	1	2	4	3	1	1	3	2	2	2	0	3	24
156	0	0	1	0	0	1	0	0	1	0	0	2	5
179	2	0	2	1	4	4	10	12	11	8	9	7	70
204	0	0	0	1	2	0	2	2	6	5	0	2	20
219	0	0	0	0	0	0	1	0	0	0	0	0	1
242	1	1	3	2	4	3	11	4	5	1	2	7	44
250	0	0	0	0	0	0	0	1	0	0	0	0	1
252	0	1	0	1	0	0	0	0	0	0	0	0	2
260	0	0	0	0	0	1	0	0	0	0	0	1	2
307	0	0	2	4	7	7	11	18	5	1	1	1	57
310	1	1	0	0	0	0	1	0	2	2	0	3	10
313	2	2	18	7	5	5	6	7	2	2	0	2	58
315	7	8	1	6	6	2	7	9	6	2	0	4	58
318	0	2	2	1	1	0	1	1	1	4	3	2	18
330	0	1	0	2	2	6	17	19	15	4	5	4	75
331	0	0	0	1	0	2	2	5	2	3	3	1	19
340	0	0	1	2	4	6	3	4	1	4	1	3	29
350	0	0	0	0	1	2	1	0	1	1	1	0	7
354	0	0	0	0	0	1	0	0	0	0	0	0	1
357	2	1	3	6	3	3	8	15	21	4	4	2	72
358	1	9	15	14	21	16	11	22	26	27	35	46	243
360	7	4	9	19	15	13	13	37	12	17	25	22	193
361	0	0	0	2	2	1	4	3	3	3	0	4	22
364	1	1	1	0	0	2	1	0	0	1	0	1	8
365	0	0	0	0	0	0	3	0	0	1	0	0	4
427	0	0	0	2	0	0	0	0	0	1	2	0	5
428	1	0	0	0	1	0	1	2	4	3	2	0	14
430	2	0	1	0	2	2	0	0	1	0	1	0	9
455	0	0	1	1	2	3	6	14	9	11	6	11	64
525	0	0	0	0	0	0	1	0	0	0	1	1	3
TOTAL	28	34	67	75	86	83	125	178	139	109	103	129	1156

TOSHIBA CORP.

PATENTS GRANTED - BY CLASS BY YEAR

CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
008	0	0	0	0	0	0	0	0	0	0	0	1	1
029	0	4	2	4	2	1	3	1	3	0	6	3	29
148	0	0	1	1	4	3	1	4	2	2	6	2	26
156	2	0	3	0	5	0	0	0	2	3	8	3	26
179	1	2	2	2	1	0	3	1	1	2	1	4	20
204	0	1	1	2	0	0	0	0	1	1	0	1	7
219	2	0	0	3	7	2	2	2	1	4	1	5	29
242	0	1	1	0	1	1	2	3	0	0	0	1	10
250	3	2	4	5	4	2	0	6	3	4	5	15	53
252	3	0	0	11	1	2	2	0	1	1	1	6	28
260	1	0	0	2	2	0	1	0	1	0	1	1	9
307	0	1	6	1	7	3	5	8	7	15	8	15	76
310	1	1	7	3	1	0	0	1	1	1	1	2	19
313	4	9	16	13	10	5	4	2	10	7	8	10	98
315	5	3	2	6	1	2	2	3	4	3	2	7	40
318	1	4	7	4	7	3	3	3	2	3	1	2	40
330	0	1	1	0	0	0	0	3	4	6	4	5	24
331	0	0	1	1	0	1	0	2	3	3	2	1	14
340	0	1	1	9	1	5	3	4	4	6	2	10	46
350	0	0	1	0	0	0	0	1	1	2	1	4	10
354	0	1	0	1	1	0	0	1	2	0	0	1	7
357	2	2	5	9	2	6	2	2	7	11	16	17	81
358	4	1	4	4	5	5	6	2	2	7	2	7	49
360	0	0	0	3	4	1	2	1	1	0	3	4	19
361	0	0	3	1	3	2	1	1	2	3	2	9	27
364	0	2	0	7	3	3	2	4	3	21	17	24	86
365	0	3	0	1	1	4	2	3	2	6	6	7	35
427	1	1	2	3	3	3	1	1	0	3	2	2	22
428	1	0	0	0	1	0	0	1	1	1	1	2	8
430	0	0	0	1	1	0	4	1	1	0	1	0	9
455	1	0	1	3	1	0	2	1	2	1	0	1	13
525	0	1	1	0	0	0	0	0	0	3	1	0	6
528	1	0	0	2	3	0	0	0	0	2	0	2	10
548	1	0	0	0	0	0	0	0	0	0	0	0	1
TOTAL	34	41	72	102	82	54	53	62	74	121	109	174	978

APPENDIX A2 - PART 1

ADDITIONAL POLICY AND LEGAL DECISIONS*
relating to
SECTION III -- SOFTWARE RELATED TECHNOLOGIES
Patentability: Past to Present

This appendix is primarily directed to patent attorneys, agents, inventors and others who are interested in the history and development of the patentability of computer related inventions. A case by case analysis is provided for all major court decisions in this area for the period 1964 through 1980 and policy matters which may have influenced these decisions are discussed.

POLICY ISSUES

Industry Approach

As stated by the Supreme Court in Diehr, "the broad question whether computer programs should be given patent protection involves policy considerations...." Entities having primary concerns in the development and sale of software, affected by their economic self interest and institutional bias, have favored patent protection for software.[62] Such protection would enable them to compete more effectively with hardware manufacturers who supply free programs with the purchase of their hardware. Since most software manufacturing companies are relatively small, the prospect of having other companies copy their product and offer it free to their customers is dismal.

Software users, such as Bell Telephone Laboratories, Inc.[63] and the large oil companies, want patent protection in order to maintain or build their prominence in particular areas of technology. Exemplary of such aggressive seeking of patent protection are the numerous appeals to the CCPA[64] filed in the seismic data processing area by major oil companies.

Spokesmen for the patent bar have consistently favored patentability.[65] On the other hand, large hardware manufacturers, such as IBM, have strongly disapproved of such patentability, as the unrestricted use of their computers serves their best interests.[66]

PTO Approach

The United States Patent and Trademark Office (PTO), concerned about patentability under 35 USC 101, has rejected patent applications directed to software.[67]

As early as 1964, the PTO denied the patentability of programs because they were "creations in the area of thought."[68] In Ex parte King and Barton,[69] the PTO Board of Appeals presented its first published opinion concerning the patentability of a digital computer for mathematically pro-

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*Section III of this publication and Appendix A2 were authored by Nelson Moskowitz, a Senior Primary Examiner, Special Laws Division, Examining Group 220. The statements and opinions expressed are those of the author and do not necessarily reflect the position or views of the Patent and Trademark Office.

cessing, by Polish Notation, data stored within the computer. The Board affirmed the Examiner's rejection but disagreed with the Examiner's approach of considering the computer with the stored program patentably indistinct from any other computer absent such program.

In 1966, the PTO set out to formulate standards for the patentability of software in its proposed first Guidelines to Examination of Programs.[70] The guidelines recommended that process claims[71] based solely on computer execution of mathematical formulas be considered unpatentable as they merely provide for the transformation of data from one form to another.[72] These guidelines also set forth another class of process claims called "utility steps." These could be patented because a transformation in the state of a general purpose computer resulted when operations software controlled the computer.[73] Under these guidelines, apparatus claims for programmable devices were to be patentable if the computer was programmed into a special purpose machine.

These guidelines were withdrawn by the PTO[74] after hearings during which they were strenuously opposed by computer hardware manufacturers who insisted that software continue to have freedom of access in order to promote and continue advancement in the technology.[75] The software firms, patent practitioners and geophysical prospecting companies, took the position that computer technology and software were merely other technologies and were entitled to equal protection under the patent laws.

During Senate hearings on the Patent Reform Act of 1967[76] the recommendations by the PTO were attacked as constituting "class legislation" in denying software manufacturers rights equal to those of hardware manufacturers. However, this reform bill died in committee.

During House hearings in 1967, former PTO Commissioner Brenner emphasized that the Patent and Trademark Office had little pertinent prior art available to the examiners since there was a lack of prior art patents and most of the literature was not in possession of the Office.[77] The Commissioner also referred to the difficulty of engaging qualified examiners for this sophisticated technology, the lack of experienced personnel, and inadequate examination procedures in the area.

In 1968, the PTO set up examination guidelines ignoring distinctions drawn in its 1966 proposal and stated specifically that computer programming, whether claimed as a process or as apparatus, was not patentable unless unobviously combined in an apparatus which effected the physical transformation of a substance.[78] Listed as exemplary of such transformation were the knitting of a pattern or the shaping of metals. The basic legal theory upon which the Office premised this opinion was that a process which could be implemented by purely mental acts was not within the scope of patentable subject matter and that a "process or method is directed to patentable subject matter only if it is performed on physical materials and produces some appreciable change in their character or conditions...." These guidelines were rescinded[79] after the Court of Customs and Patent Appeals specifically rejected them.[80]

Attempts to formulate official specific standards and guidelines for the examination and patentability of software related inventions were then abandoned by the Office.

COURT DECISIONS

Mental Steps

In 1968, the CCPA began a series of decisions challenging the previously presumed unpatentability of computer software.[81] The early CCPA decisions rejected the Office doctrine of "mental steps"[82] which contended that if the integral part of any process or machine consisted of a "mental step," i.e., a function that was, or could be, carried out in one's mind, the invention which employed it could not be patented. This doctrine as applied to software was based upon the argument that a computer operating on a program carries out an algorithm, a step-by-step procedure for solving a problem. Therefore, a patent claim setting forth an algorithm carried out by a computer would secure patent rights in the practical implementation of the algorithm. This would be, in effect, tantamount to a patent on the algorithm itself as the computer is in the prior art and only the algorithm is novel.

In the CCPA's landmark decision of November 1968, In re Prater,[83] the court declared,

> No reason is now apparent to us why, based on the Constitution, statute or case law, apparatus and process claims broad enough to encompass the operation of a programmed general-purpose digital computer are necessarily unpatentable. In one sense, a general purpose digital computer may be regarded as but a storeroom of parts and/or electrical components. But once a program has been introduced, the general-purpose digital computer becomes a special-purpose digital computer (i.e., a specific electrical circuit with or without electro-mechanical components) which, along with the process by which it operates, may be patented subject, of course, to the requirements of novelty, utility and non-obviousness. Based on the present law, we see no other reasonable conclusion.

The invention in that case was directed to the spectrographic analysis of the concentration of elements in a mixture of gases by a set of linear equations to be run in either a general purpose digital computer or a specially designed analog computer. The Patent Examiner found the set of equations to be the sole novel aspect of the invention and rejected both the process and apparatus claims as drawn to an unpatentable mental process which could be carried out with pencil and paper alone.

The CCPA particularly distinguished over (1) the Cochrane[84] requirement for a physical transformation and (2) the presumption of unpatentable mental steps. The court decided that the definition of "process" as set forth in Cochrane and argued by the Office was misconstrued, taken out of context, and was inapplicable to the processing of mathematical data. As for the "mental steps" doctrine the court decided that where a process is capable of performance without human intervention and directed to an industrial technology, it is not precluded from patent protection merely because the process could alternatively be carried out by mental steps. Where both mechanical means for performing the process are disclosed in the patent application and the mental implementation of the process is unreasonable in light of the description of the invention and the scope of the claims, the invention is directed to patentable subject matter.

This decision was so startling and in conflict with the Office's position that the Office petitioned and was granted a rehearing at the CCPA on the case.[85]

In the second Prater decision, the CCPA avoided analyzing the 35 USC 101 process rejection but reaffirmed the right of patent protection for software and its reinterpretation of the Cochrane decision. However, the court found that the language of the patent application disclosure failed to adequately limit the claimed process to its machine implementation only and therefore affirmed the Patent Examiner's rejection of the specific process claim. The claim drafted in apparatus format which covered both the analog and digital mode of implementing the process was allowed by the court.

In view of this decision, the PTO's 1968 Guidelines were withdrawn and then Commissioner Schuyler stated,[86]

> We now will consider patent applications for computer programs on the basis of the merits for the specific inventions sought to be protected rather than refuse consideration for reasons such as those discarded by the Court in the Prater and Wei case.

Bernhart

Four months after the second Prater decision, the CCPA ruled in Bernhart[87] that a computer which is programmed is physically different from that computer without that program. The invention of Bernhart was directed to a method and apparatus for mathematically projecting a three-dimensional figure onto a two-dimensional surface from any desired angle and distance on any desired plane by means of a prior art computer and plotter. A general purpose digital computer was utilized to solve a set of transformation equations whose solutions were used to drive the plotter in drawing the two dimensional representation. The Examiner had rejected the claims on the basis that the novelty in the invention lay in the equation with which the computer was programmed and that the programming of the computer was predicated on mental steps and thus unpatentable.

The court, upon review, found that since the apparatus claims contained no recitation of mental steps and did not incorporate human facilities, they were directed to a statutory category of inventions.

As for the argument raised by the Examiner that a programmed computer was structurally equivalent to the same computer without that program and that the addition of new signals to the computer did not make the computer a new machine, the court stated:

> If a machine is programmed in a certain new and unobvious way, it is physically different from the machine without the program; its memory elements are differently arranged. The fact that the physical changes are invisible to the eye should not tempt us to conclude that the machine has not been changed. If a new machine has not been invented, certainly a 'new and useful improvement' of the unprogrammed machine has been, and Congress has said in 35 USC 101 that such improvements are statutory subject matter for a patent.

As to the method claims, the court found that although they were directed to a statutory category of invention, they would have been obvious to one of ordinary skill in the art.[88]

Musgrave

Within a year of this decision, the CCPA in Musgrave,[89] further broadened the categories of inventions which could be patented. Musgrave's invention was directed to a method for obtaining more accurate recordings of seismograms in geophysical exploration by obtaining weathering corrections through the use of a digital computer. The Examiner rejected the claims on the basis that one or more steps in the process could be performed by mental acts and thus the process did not fall within the categories of patentable inventions. The CCPA reversed the Examiner's holding and formulated its own standards for defining a statutory process stating:

> We cannot agree ... that these claims ... are directed to nonstatutory processes merely because some or all the steps therein can also be carried out in or with the aid of the human mind or because it may be necessary for one performing these processes to think. All that is necessary, in our view, to make a sequence of operational steps in a statutory 'process' within 35 USC 101 is that it be in the technological arts so as to be in consonance with the Constitutional purpose to promote the progress of 'useful arts.' Constitution article 1, section 8. (Emphasis added.)

This holding broadened the qualifications of a "process" under 35 USC 101 to include any sequence of steps which could be performed by a machine

as opposed to thinking persons and which serves to promote the useful arts. As noted by Judge Baldwin in his concurring opinion, "very little remains of the 'mental steps' doctrine." In the next two CCPA opinions in this area,[90] the court made it clear that processes which have no practical value other than enhancing the internal operations of a computer are proper subject matter under 35 USC 101 for patents.

Examiner Proposals

In 1970, at the Patent Resources Group Conference,[91] two PTO Examiners proposed rules for governing the patentability of programmable processes. These rules provided that where a programmable process "has an intimate relationship to the machine, depending upon the machine's structure and organization and deriving its significance from its interrelation with or exploitation of features or characteristics of the machine, the process is statutory." Specific applications of these rules to exemplary claims for applications programs, control programs, input/output programs, and real-time processing were provided. The PTO, however, did not officially adopt these proposed rules.

Benson

The United States Supreme Court first grappled with the issue of software patentability in the case of Gottschalk v. Benson.[92] Benson and coinventor Tabbot applied for a patent for an invention directed to a method for converting numerical information from one numerical base (Binary Coded Decimal, (BCD)) into another (pure binary) by the use of a programmed digital computer.[93] The patent application specifically stated that the invention resided in the programming algorithm and included the conversion subroutine. The invention was directed to the problem of converting telephone numbers, dialed one digit at a time, into the binary form, necessary for telephone interconnection. Each digit, when dialed on a telephone, generates electrical impulses which cause it to be stored in binary form, and a complete telephone number is stored in BCD format. This BCD coded number had to be converted to pure binary code in order for it to be processed in conjunction with other telephone processing routines. This process was used in Bell Telephone Systems No. 101 Electronic Switching System for both circuit switching and generalized data processing.[94]

The Patent Examiner rejected the claimed invention as it included within its scope mental and mathematical steps which were unpatentable under 35 USC 101.[95]

On appeal, a unanimous CCPA reversed the Examiner and found that the sequence of steps set forth in the claims was within the useful, technological arts and therefore patentable as a process under 35 USC 101.[96] Judge Rich, writing the court's opinion, noted that the invention as set forth in claim 8 is to be practiced on a particular apparatus, a reentrant shift register. He also compared the use of digital computers manipulating signals representing binary numbers with cash registers, bookkeeping machines and adding machines which manipulate numbers. As the patentability of these latter analog machines[97] had not been denied under 35 USC 101, he found that no reasonable distinction could be drawn against digital computers. Claim thirteen which contained no specific recitation of apparatus was interpreted in light of the specification and was considered to be implemented with a digital computer.

The PTO filed a petition for certiorari for Supreme Court review of this case.[98] In a 6-0 decision delivered by Justice Douglas,[99] the United States Supreme Court reversed the CCPA.[100] The Court cited its decisions construing the meaning of the "process" category of inventions[101], all of which were decided under previous patent statutes[102] and which had been superseded by the 1952 patent laws.[103] The Court did not however, find a conclusive answer in these cases to the question whether the "process" category was sufficiently broad to include computer programs. The Court found that granting a patent on the claims at issue would, in effect, preempt the idea or algorithm embodied in the method since the only practical use for the algorithm was in a digital computer. The Court further stated that innovations in the technology of processing data in digital computers are not patentable under the present statutes.

Contrary to the CCPA, and even though claim eight specifically called for the use of a reentrant shift register, the Supreme Court found the inventions described in both claims 8 and 13 could be performed without a computer and that these claims were not limited to any particular apparatus. The claims were considered to be so broad in scope that they included all possible applications of the invention, thus capable of giving a monopoly on the the algorithm itself.

The Court specifically stated that this decision does not preclude a patent for any program servicing a computer, does not extend to analog computers, and does not limit process patents to old technologies. No ruling was reached on the mental step doctrine.

The Court concluded its opinion without having cited any of the CCPA's previous decisions and obliquely recognized that the issue at hand was "...a policy matter, to which we are not competent to speak." Citing several paragraphs from the Report of the President's Commission on the Patent System,[104] the Court concluded its opinion by admonishing the legislature that "considered action by Congress is needed." The reluctance of the Court to formulate new policy and rules may be attributed to the problems attached to appropriate proprietary protection for software as noted by Judge Rich of the CCPA:

> The technology is ... mathematically awesome, the economic impact of our decision tremendous, and the administrative problems of the Patent Office horrendous ...[105]

In the intervening years between Benson and Dann v. Johnston,[106] when the Supreme Court again decided to review a case directed to program patentability, the Patent Office continued to reject claims directed to software and relied heavily on Benson for authority as to this position. The CCPA, on the other hand, attempted to carve out sections of software technology for which patents could be granted.

Christensen

The first case decided by the CCPA following Benson was In re Christensen.[107] The invention in Christensen was directed to a process for determining the porosity of a subsurface formation in order to analyze lithologic formations. The claimed method recited a series of prior art steps for obtaining the necessary data and a novel equation for computing the porosity

of the formation. The Patent Examiner rejected the claimed invention under 35 USC 103 as obvious over the prior art stating that the alleged advance over the art resided in nonstatutory subject matter: a novel quadratic equation. The Board of Patent Appeals, in affirming the Examiner's rejection, amplified that the applicable claims were primarily unpatentable under the provisions of 35 USC 101.

The CCPA took this point of novelty approach in analyzing the claims and found the equation, which was the crux of the invention, to be the sole novel step claimed and thus the claims unpatentable. The addition of old and necessary antecedent steps for establishing values for variables to be-operated on was not sufficient to render the claimed method patentable.[108]

Johnston

The next case directed to a programmable invention, In re Johnston,[109] was decided by the CCPA, and was also appealed to and decided by the Supreme Court. This case was the first among many wherein the CCPA overruled the Patent Examiner and permitted patent claims combining apparatus and process which were directed to inventions where the program was viewed as creating a new machine.[110] In patent applications where the claims were directed to computational steps per se, the CCPA found the inventions to be unpatentable.[111] The CCPA found the inventions to be patentable when the claims used or applied the algorithm to achieve noncomputational results.[112]

In Johnston, the invention was directed to a computer program for controlling automated banking devices for machine handling of transactions, in particular, the sorting of checks into prearranged categories. The Examiner had rejected the claims under 35 USC 101 as directed to a nonstatutory category of invention.[113]

The CCPA, by a three to two decision, reversed all of the Examiner's rejections and narrowly construed Benson to apply only to process type inventions.[114] Chief Judge Markey, in the dissent, found the claimed invention to be obvious in view of the prior art to those skilled in the art of record keeping machines, a position that the Supreme Court later shared.

The Supreme Court reversed the majority opinion of the CCPA but did not directly address the issues presented under 35 USC 101. The Court decided that Johnston's invention was obvious and noted that its decision in Benson was a limited holding.

The PTO tried three times almost immediately thereafter to have the Supreme Court take up the issue of the patentability of software related inventions.[115] The first two attempts, in Chatfield and Noll, were unsuccessful. The Supreme Court declined to consider the cases on the grounds that the Office's petitions to that Court in Chatfield were not timely filed and that the Noll application was expressly abandoned by the applicant. The third petition, in Flook, was accepted by the Supreme Court.

Flook

The invention in Flook[116] was directed to a three step method for updating alarm limits. A mathematical algorithm was used to compute the values of environmental limits such as temperature, pressure, and flow rates in a catalytic hydrocarbon conversion process and then use these values to update the process alarm limits. The first step of the process measured the process variables value. The second step calculated an updated alarm limit value. The third step constituted replacing the old alarm limit with the newly computed value.

The sole novelty in the claimed[117] invention was in the mathematical algorithm used in computing the updated alarm limit value. Although the claims covered a large variety of potential uses of the invention they did not cover every conceivable application of the algorithm. The Examiner rejected the claimed invention as being directed to nonstatutory subject matter.

The CCPA reversed the Examiner on the basis that although the claim recited an algorithm to be used in carrying out the invention, it did not preempt the algorithm. The court also noted that the claims in question presented a sufficient step in the form of an adjustment of an alarm limit after the solution of the algorithm.

The PTO and Justice Department found this decision particularly unpalatable since knowledgeable patent practitioners could easily draft claims for software related inventions and recite a post-solution activity which would be broad enough to cover an entire field of technology.[118] A patent on such claims would then preempt practically all uses of such claimed inventions. The Supreme Court, in January of 1978, granted certiori. Justice Stevens, writing for the majority of the Supreme Court in a 6-3 decision, reversed the decision of the CCPA and dissallowed the patent claims.

The Court found the invention unpatentable because the algorithm, like a law of nature or scientific principle, is assumed to be in the prior art. The claimed invention therefore, considered as a whole, contained no patentable subject matter.[119]

The Court further rejected the CCPA ruling that post-solution activity in and of itself was sufficient to transform an unpatentable invention into a patentable one. The test for patentability set forth was whether the complete process as claimed, not just the algorithm or formula, is new and useful. Laws of nature, such as algorithms, could not be patented because they reveal a relationship which always existed and as such are not the type of discoveries for which the statutes were enacted to provide patent rights.

However, the Court agreed with the CCPA that Flook's claims would not wholly preempt the algorithm and would not in practical effect be a patent on the algorithm.

The Court affirmed that some computer programs may be patentable and stated:

> This decision should not be interpreted as reflecting a judgement that patent protection of certain novel and useful computer programs will not promote the progress of science and the useful arts, or that such protection is undesirable as a matter of policy.

The Court again noted its concern as to which software is suitable for patent protection and requested Congress to settle this difficult issue of policy.

Hirschfeld

The first case to come up for review following Flook was Hirschfeld v. Banner.[120] Chief Judge Markey of the CCPA, sitting by designation in the District Court, found that a invention directed to increasing the dynamic range for a digitally controlled television camera tube whose output signals were stored in a digital computer was directed to statutory subject matter. The court found that since the claims did not directly or indirectly recite a mathematical algorithm, the claimed invention could not be directed to a mathematical algorithm.

Sarkar

Soon thereafter, Chief Judge Markey wrote the first post Flook interpretive opinion of that court in Sarkar.[121] The invention in Sarkar was directed to a technique for mathematically modeling the flow parameters of an open channel of a river which is obstructed by dams or bridges, and which experiences flooding, has lateral inflow, has inflow upstream, or empties into a tidal body.

The CCPA affirmed the Examiner's rejection of the claimed invention as not being directed to a process within the scope of 35 USC 101. The court emphasized that in determining the statutory categories of invention under 35 USC 101, the consideration of novelty and unobviousness under 35 USC 102 and 35 USC 103 have no place. The claimed invention was found to be broad enough to preclude all uses of the algorithm and thus preempt it.

Johnson

The next case to be decided by the CCPA was Johnson.[122] The invention in Johnson was directed to a computer-implemented method of filtering noise from data obtained in seismic prospecting by analysis and comparison of different parts of collected data.

The Patent Examiner rejected all the claims under 35 USC 101 as directed to non-statutory subject matter. The CCPA, in a unanimous opinion, reversed the Examiner, deciding that Johnson's invention was not directed to a mathematical formula and the end result of Johnson's process was a recording of noiseless seismic traces, not a numerical value derived by a mathematical formula as in Flook.

The court then applied its two-pronged test, first formulated in Freeman,[123] to determine whether the claims recited non-statutory subject matter. First, the claims were reviewed to determine whether they directly or indirectly recite process steps which were themselves calculations,

formulae or equations; secondly, the claims taken in their entirety were analyzed to see if they wholly preempt these calculations, formulae or equations. As to the first test, the court found the claim language of "determining" and "computing" to suggest the execution of a mathematical algorithm and, although no formula was specifically set out in the claims, one was implicitly required. In view of the second step, the court found that the claims do not merely define a method of solving a mathematical algorithm and that the algorithmic steps of "determining" and "computing" were incidental to producing a noise free seismic trace.

Gelnovatch

The next two cases decided before the Supreme Court decisions of Diehr and Bradley[124] were Gelnovatch[125] and Arshal.[126] In Gelnovatch, a divided CCPA affirmed the Examiner's rejection of the claimed invention as directed to a non-statutory process.

The invention was directed to a process for determining a set of values for use in a mathematical model of a microwave circuit. The model used mathematical equations describing the functional characteristics of the circuit components and the manner in which the components interrelate. Electrical components which match those of the model would permit building such a circuit and have a specified response.

The court found the claimed invention distinguishable from Flook; for although the equations claimed did not determine an output value from input values, this was not significant since in the instant invention, the answer was specified prior to performing the calculations. The court stated where "the claims solely recite a method whereby a set of numbers is computed from a different set of numbers by merely performing a series of mathematical computations, the claims do not set forth a statutory process."

Arshal

In Arshal, the Court of Claims considered an infringement[127] suit against the United States. Arshal alleged that the U.S. Department of the Navy had infringed his patent[128] to a directional computer.

The Court found the situation here similar to that in Christensen and granted the government's request for summary judgement. Particularly noteworthy in this decision are the court's statements that although the claims at issue were in apparatus format and although the claims preamble called for a "directional computer," allegedly a particular technology, since the claims would preempt the mathematical equation, they were not within the statutory categories of invention. This had the effect of negating any distinction between apparatus and process claims.

Maucorps

This distinction between apparatus and process claims was also dispensed with by the CCPA in Maucorps[129] where the court stated that since the form of a claim is often an exercise in drafting, the test for patentability under 35 USC 101 applies without regard to such format use in the claims.

Walter

Of the two remaining cases[130] decided by the CCPA,[131] Walter is most significant. Walter's invention was directed to a method and apparatus for processing of seismic exploration data using Fourier transforms and cross-correlation by Cooley-Tukey algorithms. The Patent Examiner rejected the claims on the basis that they were directed to the mathematical procedure outlined in the specification for cross-correlating the sets of seismic signals.

Beginning his opinion for the court, Judge Rich stated:

> The determination of statutory subject matter under Section 101 in the field here involved has proved to be one of the most difficult and controversial issues in patent law. The problem here, as we see it, is not one of computer-related inventions per se; it is one of mathematics-related inventions.

In analyzing the claims the court found that the specific end use recited, seismic surveying, did not save the claims from the holding in Flook, since they were drawn solely to improved methods of calculations. The court distinguished over Johnson by noting that in Johnson, a noiseless seismic trace was produced, a physical product, while here no physical product resulted.

The court also broadened its second test as set forth in Freeman, noting that Flook did not require a total preemption of the algorithm of the invention, but that this did not conflict with its Freeman test. The new second step defined by the court was:

> Once a mathematical algorithm has been found, the claim as a whole must be further analyzed. If it appears that the mathematical algorithm is implemented in a specific manner to define structural relationships between the physical elements of the claim (in apparatus claims) or to refine or limit claim steps (in process claims), the claim passes muster under 101. If, however, the mathematical algorithm is merely presented and solved by the claimed invention, as was the case in Benson and Flook, and is not applied in any manner to physical elements or process steps, no amount of post-solution activity will render the claim statutory; nor is it saved by a preamble merely reciting the field of use of the mathematical algorithm.
>
> Various indicia are helpful in determining whether a claim as a whole calls merely for the solution of a mathematical algorithm. For instance, if the end-product of a claimed invention is a pure number, as in Benson and Flook, the invention is nonstatutory regardless of any

> post-solution activity which makes it available for use by a person or machine for other purposes. If, however, the claimed invention produces a physical thing, such as the noiseless seismic trace in In re Johnson, supra, the fact that it is represented in numerical form does not render the claim nonstatutory.

This new test requires the mathematical algorithm to be implemented to define a structural relationship between the claimed elements or to refine the claimed elements or to refine or limit physical process steps.

It was finally the applications of Bradley and Diehr which provided the impetus of the policy changes necessary to clarify and simplify the categories of software related inventions subject to patent protection.

* * *

APPENDIX A2 - PART 2

CITATIONS AND NOTES
relating to
SECTION III -- SOFTWARE RELATED TECHNOLOGIES
Patentability: Past to Present

How To Find The Citations

For those readers who want a fuller understanding of the publications discussed, the citations generally have the same format -- volume, name of publication, series, and page number -- followed, where applicable, in parentheses by the court involved and the year. Exemplary abbreviations used are:

F.2d	-- Federal Reporter, Second Series
U.S.	-- United States Reports (official reports of the U.S. Supreme Court)
U.S.C.	-- United States Code
U.S.P.Q.	-- United States Patents Quarterly
O.G.	-- Official Gazette of the U.S. Dept. of Commerce, Patent and Trademark Office
J.P.O.S.	-- Journal of the Patent Office Society
M.P.E.P.	-- Manual of Patent Examining Procedure

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1 602 F.2d 982, ,209 U.S.P.Q. 1, aff'd, Diamond v. Diehr, (1981 US) 67 L.Ed. 2d 155 (March 3, 1981), Patent application assigned to Federal Mogul Corp.

2 600 F.2d 807, 202 U.S.P.Q. 480, aff'd, Diamond v. Bradley, (1981 US) 101 S. Ct. 1495, 209 U.S.P.Q. 97, Patent application assigned to Honeywell Infor. Sys. Inc.

3 See "Guidelines to Examination of Programs", 829 O.G. 1, (August 21 1966) and Schuyler, "Examination of Patent Applications on Computer Programs - Nature of Decision of Guidelines", 868 O.G. 349 (November 11, 1969).

4 New MPEP Section 2110. Examination of Patent Applications Involving Mathematical Algorithms or Computer Programs. For full text see Appendix A2-Part 3.

5 Rosenberg, Jerry M., The Computer Prophets (Macmillan, 1969).

6 Rhode, Alfred, "Die Geschichte der Wissenschaftlichen Instuumente vom Beginn der Renassance bis zum Ausgang des 18. Jahrhunderts." (Leipzig, Klinkhardt & Biermann, 1923).

7 Prager, Frank D. "Examination of Inventions from the Middle Ages to 1836", XLVI J.P.O.S. 268, 280 (1964)

8 Halacy, Dan, Charles Babbage, Father of the Computer, Crowell Collier, (1970).

9 Charles Babbage and His Calculating Engines, Dover Pub., Inc. (1961).

10 Fagan, Impact, Bell Telephone Laboratories (1971), pg. 115.

11 ENIAC stands for Electronic Numerical Integrator And Computer. Patent No. 3,120,606 was granted to Eckert and Mauchly for the ENIAC.

12 Goldstine, et al., "The Electronic Numerical Integrator And Computer (ENIAC)", Math Tables and Aids 2 (1946).

13 Williams, et al, "A Storage System for Use with Binary Digital Computing Machines", Proc. IEE 96, Pt. 3 (March 1949).

[14] Wilkes, et al, "The EDSAC, an Electronic Calculating Machine", J. Sci. Instrum. 26 (December 1949) pg. 385.

[15] Kilburn, et al., "Digital Computers at Manchester University", Proc. IEE 100, Pt. 2 (1953), pg. 487.

[16] MacMillan, et al., "Floating Decimal Calculations on the IBM Card Programmed Electronic Calculator", Math Tables and Aids 5 (1951), pg. 86.

[17] Stiblitz, U.S. patent 2,666,579, filed December 26, 1944 and issued January 19, 1954.

[18] Von Neumann, "First draft on a report on the EDVAC", Rep. on Contract No. W-670-ORD-492, Moore School of Elect. Eng., University of Pennsylvania, Philadelphia, PA (1945).

[19] Eckert, et al., "The UNIVAC System", Proc. Joint AIEE-IRE Compt. Conf. (1951), pg. 6.

[20] Ulam, Computers, 211 Sci. Am. 203 (1964).

[21] Lanzarotta, "Computing Power at Huntsville", 6 Datamation (July-August 1960), pg. 18.

[22] See In re Waldbaum, 457 F.2d 997, 998 (CCPA 1972) and In re Ghiron, 442 F.2d 985, 986 (CCPA 1971) for equivalent judicial definition.

[23] The definition of the term algorithm as used judicially has varied significance depending upon the definer. The Supreme Court in Gottschalk v. Benson, 409 U.S. at 65 stated: "A procedure for solving a given type of mathematical problem is known as an algorithm." The Court reiterated this definition in Parker v. Flook 437 U.S. at 585 and in Diehr, supra at 1. The Court of Customs and Patent Appeals (CCPA) defined the term algorithm to refer to methods of calculating mathematical formulas and mathematical procedures generally, In re Walter, 618 F.2d at 758. The PTO Board of Appeals has used the following dictionary definition in In re Toma, 575 F.2d at 876 n. 4: 1. A fixed step-by-step procedure for accomplishing a given result; usually a simplified procedure for solving a complex problem; also a full statement of a finite number of steps. 2. A defined process or set of rules that leads and assures development of a desired output from a given input. A sequence of formulas and/or algebraic/logical steps to calculate or determine a given task; processing rules.

[24] Supra at 5.

[25] U.S. Const. Art. I, sec. 8, cl.8.

[26] The subject matter of a patent is limited to a "process, machine, manufacture, or composition of matter, or any new or useful improvement thereof," 35 USC 101 (1976). The term process means process, art or method and includes a new use of a known process, machine, manufacture, composition of matter, or material." 35 U.S.C. 100 (b). The term "process" has been further defined by the United States Supreme Court as a series of actions upon certain materials that transforms its subject matter from one state to another state or thing. Cochrane v. Deener, 94 U.S. 780 (1877).

[27] 35 U.S.C. 101 (1979).

[28] 35 U.S.C. 101 and 102 (1979). 35 U.S.C. 102 reads as follows:

Conditions for patentability; novelty and loss of right to patent

A person shall be entitled to a patent unless-

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this

country, more than one year prior to the date of the application for patent in the United States, or

(c) he has abandoned the invention, or

(d) the invention was first patented or caused to be patented, or was the subject of an inventor's certificate, by the applicant or his legal representatives or assigns in a foreign coutry prior to the date of the application for patent in this country on an application for patent or inventor's certificate file more than twelve months before the filing of the application in the United States, or

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent, or

(f) he did not himself invent the subject matter sought to be patented, or

(g) before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it. In determining priority of invention there shall be considered not only the respective dates of conception and reduction to practice of the invention, but also the reasonable diligence of one who was first to conceive and last to reduce to practice, from a time prior to conception by the other.

29 35 U.S.C. 103 (1979). 35 USC 103 reads:

Conditions for patentability; non-obvious subject matter

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

30 35 U.S.C. 112 (1979). 35 USC 112 reads:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

A claim may be written in independent or, if the nature of the case admits, in dependent or multiple dependent form.

Subject to the following paragraph, a claim in dependent form shall contain a reference to a claim previously set forth and then specify a further limitation of the subject matter claimed. A claim in dependent form shall be construed to incorporate by reference all the limitations of the claim to which it refers.

A claim in multiple dependent form shall contain a reference, in the alternative only, to more than one claim previously set forth and then specify a further limitation of the subject matter claimed.

A multiple dependent claim shall not serve as a basis for any other multiple dependent claim. A multiple dependent claim shall be construed to incorporate by reference all the limitations of the particular claim in relation to which it is being considered.

An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, materials, or acts described in the specification and equivalents thereof.

[31] Gottschalk v. Benson, 409 U.S. 63, 67 (1972) and Rubbertip Pencil Co. v. Howard, 87 U.S. 498 (1874).

[32] Le Roy v. Tatham, 55 U.S. 156 (1853); O'Reilly v. Morse, 56 U.S. 62 (1854).

[33] Eibel Process Co. v. Minnesota & Ontario Paper Co., 261 U.S. 45 (1923).

[34] Bradley's claimed invention, as defined in his two independent claims, reads:

> 1. In a multiprogramming computer system having a main memory, a central processing unit (CPU) coupled to said main memory, said (CPU) controlling the state of a plurality of groups of processes being in a running, ready, wait or suspended state, said computer system also having scratchpad registers being accessible to an operating system for controlling said multiprogramming computer system, a data structure for storing coded signals for communicating between said processes and said registers, said data structure comprising:
> (a) first means in said data structure and communicating with said operating system for storing coded signals indicative of an address for a selected one of said processes;
> (b) second means in said first means for storing coded signals indicating priority of said selected one of said processes in relation to others of said processes for obtaining control of said CPU when ready;
> (c) third means in said data structure and communicating with said operating system, for storing coded signals indicative of an address for a selected one of said plurality of groups of processes, and,
> (d) fourth means coupled to said data structure and said scratchpad registers, for generating signals causing the changing of information in said data structure and said scratchpad registers.
>
> 2. In combination with a communication center located in a predetermined area of computer main memory the computer having a

central processing unit (CPU) for executing plurality of processes that compete with each other for control of said CPU, operating system means coupled for providing information to said communication center, and a scratch pad memory in said CPU which stores, under control of said operating system means, portions of information located in said communication center, an improved system controlled by one of said processes for changing information in said communication area and in said scratchpad memory, said improvement comprising:

(a) first means for generating signals causing the creation of an image of said communication center at another location in said main memory;

(b) second means responsive to said operating system means for generating signals causing a change of the information in said image, resulting in a new image; and,

(c) third means, coupled for being responsive to said first and second means and to one of said processes for generating signals for causing a transfer of the new image to said communication center and to said scratchpad memory.

35 The system base controls the operation of the computer; it contains the process information used by the computer to carry out programmed operations.

36 To change the data in the scratchpad registers the programmer has had to reprogram the entire system base, a time consuming task, or use software limited to that particular computer model, an option unacceptable to many computer users.

37 Bradley's firmware is stored in a control memory of the programmable read only memory (PROM) type, which can be microprogrammed by the user.

38 When the programmer activates what Bradley calls a "switch system base instruction", this initiates the execution of a microprogram that transfers the data.

39 The Examiner futher noted in his answer before the Patent and Trademark Office Board of Appeals that microprogrammed control units like Bradley's were also old in the art. Thus, he concluded that the invention "resides in an instruction in firmware which changes upon execution, information in the system base."

40 In re Bradley, supra at 2.

41 573 F.2d 1293 (CCPA 1978); Decided prior to the Supreme Court decision in Flook but the test was not affected by the Flook decision.

42 Appeal. No. 79-855.

43 Chief Justice Burger took no part in the consideration or decision of this case.

44 The geometric configuration of the press and the viscosity of the rubber when it enters the press are important factors in computing the cure time.

[45] Claim one of the eleven claims appealed reads:

> Claim 1. A method for operating a rubber-molding press for precision molded compounds with the aid of a digital computer, comprising: providing said computer with a data base for said press including at least, natural logarithm conversion data (ln), the activation energy constant (C) unique to each batch of said compound being molded, and a constant (x) dependent upon the geometry of the particular mold of the press, initiating an interval timer in said computer upon the closure of the press for monitoring the elapsed time of said closure, constantly determining the temperature (Z) of the mold at a location closely adjacent to the mold cavity in the press during molding, constantly providing the computer with the temperature (Z), repetitively calculating in the computer, at frequent intervals during each cure, the Arrhenius equation for reaction time during the cure, which is ln v=CZ+x where (v) is the total required cure time, repetitively comparing in the computer at said frequent intervals during the cure each said calculation of the total required cure time calculated with the Arrhenius equation and said elapsed time, and opening the press automatically when a said comparison indicates equivalence.

[46] In re Diehr, 602 F.2d 982 (CCPA 1979).

[47] 205 USPQ 488.

[48] 447 U.S. 303 (1980). The affirmance of the CCPA position was by a 5-4 majority, led by Chief Justice Burger. The assignee of the patent is the General Electric Company.

[49] Act of Feb. 21, 1793, ch.11, sec. 1,1 Stat. 318.

[50] S. Rep. No. 1979, 82d Cong., 2d Sess., 5 (1952), H.R. Rep. No. 1923, 82d Cong. See 2d Sess., 6 (1952).

[51] 397 F.2d 856 (CCPA 1968).

[52] Supra at 46.

[53] Mark Nusbaum, SPE, Chairman.

[54] Supra at 41. The test provides for first determining whether the claims directly or indirectly recite process steps which are themselves calculations, formulae or equations, and secondly determining whether the claims taken in their entirety wholly preempt these calculations, formulae or equations.

The second part of the test was subseqently modified by the CCPA in In re Walter, 618 F.2d 758, 205 U.S.P.Q. 397 (CCPA 1980), wherein the court restated it to be:

> Once a mathematical algorithm has been found, the claim must be further analyzed. If it ap-

pears that the mathematical algorithm is implemented in a specific manner to define structural relationships between the physical elements of the claims (in apparatus claims) or to refine or limit claim steps (in process claims), the claim being otherwise statutory, the claim passes muster under 101. If, however, the mathematical algorithm is merely presented and solved by the claimed invention, as was the case in Benson and Flook, and is not applied in any manner to physical elements or process steps, no amount of post-solution activity will render the claim statutory; nor is it saved by a preamble merely reciting the field of use of the mathematical algorithm. Various indicia are helpful in determining whether a claim as a whole calls merely for the solution of a mathematical algorithm. For instance, if the end-product of a claimed invention is a pure number, as in Benson and Flook, the invention is nonstatutory regardless of any post-solution activity which makes it available for use by a person or machine for other purposes. If, however, the claimed invention produces a physical thing such as the noiseless seismic trace in In re Johnson, supra, the fact that it is represented in numerical form does not render the claim nonstatutory.

This new test requires the mathematical algorithm to be implemented to define a structural relationship between the claimed elements or to refine or limit physical process steps.

55 Arshal v. United States, 208 U.S.P.Q. 397 (U.S. Court of Claims 1980).

56 146 U.S.P.Q. 590 (BPA 1964).

57 Supra at 3.

58 431 F.2d 882 (CCPA 1970).

59 Supra at 31.

60 In re Johnston, 502 F.2d 765 (CCPA 1974), rev'd sub. nom., Dann v. Johnston, 425 U.S. 219 (1976); In re Chatfield, 545 F.2d 152, CCPA 1976 cert. den. 434 U.S. 875 (1977); In re Noll, 545 F.2d 141 (CCPA 1976), cert. den. 434 U.S. 875 (1977); In re Flook, 559 F.2d 21 (CCPA 1977) rev'd, Parker v. Flook, 437 U.S. 584 (1978).

61 In re Johnston and In re Flook, id.

62 Brief Amicus Curiae for ADAPSO in Parker v. Flook, Supra.

63 Response to views solicited by the PTO in 885 O.G. 555, October 15, 1968 by Bell Telephone Laboratories. "Comments on Study of Computer Program Protection," December 9, 1968. Also see Benson, supra.

64 In re Abrams, 188 F.2d 165 (CCPA 1951); In re Prater, 415 F.2d 1393 (CCPA 1968); modified on rehearing, 415 F.2d 1398 (CCPA 1969); In re Musgrave, 431 F.2d 882 (CCPA 1970); In re Christensen, 478 F.2d 1392 (CCPA 1973); In re Johnson, 589 F.2d 1070 (CCPA 1978); In re Walter 618 F.2d 758 (CCPA 1980); In re Sherwood, 613 F.2d 809 (CCPA 1980) cert. den., Diamond v. Sherwood, (1981 US), 101 S. Ct. 1694.

65 Brief Amicus Curiae for the Los Angeles Patent Law Association in Diamond v. Bradley and Diamond v. Diehr, Supra at 1 and 2.

66 Brief Amicus Curie for Business Equipment Manufacturers Association in Gottschalk v. Benson, Supra. Amicus briefs supporting the CCPA's conclusion in both Bradley and Diehr were filed by the American Patent Law Association; the Los Angeles Law Association; Halliburton Services; Applied Data Research, Inc., and Whitlaw Computer Systems Inc. (joint brief). An amicus brief urging reversal of the CCPA's decisions was filed by National Semiconductor Corporation.

67 855 O.G. 829-30 (October 22, 1968).

68 Puckett, "The Limits of Copyright and Patent Protection for Computer Programs," 16 ASCAP, Copyright Law Symposium 81 (1968), at 119.

69 Supra at 56.

70 Supra at 3.

71 A patent application must be filed in accordance with 35 USC 111-113 and 115. Part of the patent application is the specification, which includes a disclosure of the invention and one or more claims defining the invention. The claims legally define the scope of the invention for which an applicant seeks patent protection. Apparatus claims are used to define inventions falling within the statutory classification of a machine. Method claims, also called process claims, are used to define inventions falling within the statutory classification of a process.

72 "Special problems of patentability arise in the computer, data processing and automatic control field that revolve around mathematical processes and equations. These problems may be more generically stated as the broad field of algorithms which are conclusions based upon a precise or mathematical premise or line of reasoning.

For example the prediction as to the winner in a presidential election made by a programmed 'general purpose' computer based on an algorithm... which has been evolved from a line of reasoning based on known factors and is analogous to the mathematical formula. Similarly, business practices or methods may be reduced to an algorithm.

Mathematical process discoveries and mathematical formulas used therein may not be patented although they may be of enormous importance (e.g., $E = mc^2$)." 829 O.G. at 865.

73 "To distinguish between algorithm and utility processes becomes difficult in the case of a programmed general purpose computer unless the distinction between a result of method or apparatus operation and the function of the method steps or apparatus component is maintained.

The result of a programmed operation of a computer may be the mathematical transformation of data according to an algorithm but the functioning of a computer is the change in state of certain electrical or mechanical devices within the computer according to the algorithm, as distinguished from the individual or total computational result of the components thereof.

Thus a process, defined as a series of steps for the manipulation or evaluation of data, even though it is required to be carried out by a programmed computer, would be an algorithm process. A process defined as a series of steps for causing a sequence of changes in state of components of the computer, even though the sequence is dictated by an algorithm, would be a utility process." Id.

74 868 O.G. 349 (November 11, 1969).

75 Report of the Hearings on the Patent Office's Guidelines to Examination of Programs, Ward and Paul, Washington, D.C. (1966).

76 Hearings on S. 1042 before Subcomm. on Patents, Trademarks, and Copyrights of the Senate Comm. on the Judiciary, 90th Cong. 1st session 75, 1-52 (1967).

77 Hearings on H.R. 5924, H.R. 1395 and Related Bills before subcommittee No. 3 of the House Comm. on the Judiciary, 90th Cong., 1st Sess., 1 ser. 11 at 37.

78 855 O.G. 829 (1969).

79 858 O.G. 349 (1969).

80 In re Prater, 415 F.2nd 1378 (CCPA 1968); modified on rehearing, 415 F.2d 1393 (CCPA 1969)

81 Id.

82 Substantial legal precedent existed for this doctrine. In re Yuan, 188 F.2d 377, (CCPA 1951); In re Abrams, 188 F.2d 165, (CCPA, 1951).

83 Supra 80 at 48.

84 Supra at 26.

85 415 F.2d 1378 (1969).

86 Woodcock, "Mental Steps and Computer Programs", 52 J.P.O.S. 275, 284 (1970).

87 417 F.2d 1395 (CCPA 1969).

88 The standard for obviousness is set forth in 35 USC 103, supra at 29.

89 Supra at 58.

90 In re McIlroy, 442 F.2d 1397 (CCPA 1971) and In re Waldbaum, 457 F.2d 997 (CCPA 1972).

91 Software patents, March 23-26, 1970, Dorado Hilton, Puerto Rico, Examiners R.D. Bennett and D.C. Kaufman.

92 Supra at 31.

93 In both BCD and pure binary number systems all numbers are represented by the arrangement of the digits "0" and "1." BCD is a hybrid of both the decimal and the binary system. Like decimal, the digits zero through nine multiply powers of ten to yield the desired number. The individual digits of the number however, are expressed in binary form.

94 During this time period, IBM developed its own electronic switching system, Model 2750, which was marketed only in Europe. This system was in a competitive position with the Bell Telephone PBX and Centrex systems. "Paper on the IBM 2750 Voices and Data Switching System". IBM J. Res. Dev. 13, 4 (July 1969), 408-455.

95 Only claims 8 and 13 of Benson's and Tabbot's patent application were litigated on appeal. They read as follows:

> Claim 8. The method of converting signals from binary coded decimal form into binary which comprises the steps of:
> (1) sorting the binary coded decimal signals in a reentrant shift register,
> (2) shifting the signals to the right by at least three places, until there is a binary "1" in the second position of said register,
> (3) masking out said binary "1" in said second position of said register,
> (4) adding a binary "1" to the first position of said register,
> (5) shifting the signals to the left by two positions,
> (6) adding a "1" to said first position, and
> (7) shifting the signals to the right by at least three positions in preparation for a succeeding binary "1" in the second position of said register.

Claim 13. A data processing method for converting binary number representations comprising the steps of:
(1) testing each binary digit position 1, beginning with the least signficant binary digit positions, of the most significant decimal digit representation for a binary "0" or a binary "1";
(2) if a binary "0" is detected, repeating step (1) for the next least significant binary digit position of said most significant decimal digit representation;
(3) if a binary "1" is detected, adding a binary "1" at the (1+1)th and (1+3)th least significant binary digit positions of the next lesser significant binary digit position of said most significant decimal digit representation;
(4) upon exhausting the binary digit positions of said significant decimal representation, repeating steps (1) through (3) for the next lesser significant decimal digit representation as modified by the previous execution of steps (1) through (3); and,
(5) repeating steps (1) through (4) until the second least significant decimal digit representation has been so processed.

96 In re Benson, 441 F.2d 682(C.C.P.A. 1971), rev'd, Gottschalk v. Benson, 409 U.S. 63, (1972).

97 There are two basic types of modern computers; analog and digital. In analog computers, data are represented as physical quantities instead of numbers, and an analog device computes by measuring the quantities through physical analog to the phenomenon. Examples of simple analog computers are a thermometer and a slide rule.

Digital computers represent data in the form of discrete numbers or digits, instead of physical quantities. Information is represented in the various components of a computer in a form which requires only two distinct states of a storage position: "on" or "off." The circuitry and mechanical apparatus used for storing one number in a computer is known as a register. A shift register is a register within which a number may be reoriented by a circular permutation. D. Eadie, Introduction to the Basic Computer, 4-8 (Prentice-Hall, Inc., 1968).

98 405 U.S. 915 (1972).

99 Supra 82 at 73. Justices Stewart, Blackmun and Powell did not participate in the decision.

100 At least 16 organizations filed amicus briefs in Benson. Among them were Honeywell Inc., Burroughs Corp., I.B.M. Inc., Institutional Networks Corp., Computer Software Analysts Inc., Computerized Lists Corp., Whitlow Computer Systems, Inc., Iowa State University Research Foundation, Inc., Business Equipment Manufacturer's Association, The Information Industry Association, Applied Data Research, Inc., and Data Processing Service Organizations, Software Products and Service Section. 409 U.S. at 63-64. The hardware manufacturers sided with the Patent and Trademark Office while the software companies, the geophysical exploration industry, and the

patent law associations sided with Benson and Tabbot.

101 Smith v. Snow, 294 U.S. 1 (1935), reh. den., Smith v. Snow, 301 U.S 670 (1937); Waxham v. Smith, 294 U.S. 20 (1935), reh. den. McCrea v. U.S., 294 U.S. 282 (1935); Expanded Metal Co. v. Bradford, 214 U.S. 366 (1909); The Telephone Cases, 126 U.S. 1 (1888); Tilghman v. Proctor, 102 U.S. 707 (1881); Cochrane v. Deener, Supra at 26; Corning v. Burden, 56 U.S 252 (1854).

102 Act of April 10, 1790, c.7, 1 Stat. 109; Act of July 4, 1836 c. 357, 5 Stat. 117; Act of July 8, 1870, c. 230, 16 Stat. 198.

103 35 U.S.C. 1 (1979).

104 Exec. Order No. 11215, 30 Fed. Reg. 4661 (1965).

105 Supra at 80 (dissenting opinion).

106 Supra at 60.

107 478 F.2d 1392 (CCPA 1973)

108 The CCPA's point of novelty approach in this case and in the cases of In re Abrams, 188 F.2d 165 (CCPA 1951) and In re Yuan, 188 F.2d 377 (CCPA 1951) were inconsistent in approach with later CCPA decisions. In Abrams the invention was directed to a hydrocarbon prospecting method wherein data was processed. The CCPA found that the only technological advance in the claimed method resided in the processing steps of "measuring," "determining" and "comparing" and that these were purely mental steps and thus unpatentable. In Yuan the invention was directed to a method of determining the airfoil profile most suitable for particular aerodynamic characteristics by particular mathematical relationships and procedures. The CCPA found these steps to be purely mental and not a patentable process. The CCPA first rejected this approach in In re Prater, 415 F.2d 1378 (CCPA 1968), subsequently vacated and replaced by an opinion which did not discuss propriety of the "point of novelty" test. See 415 F.2d 1393 (CCPA 1969). The CCPA reaffirmed its rejection of the "point of novelty" test in In re Musgrave, 431 F.2d 882, (CCPA 1970), and pointed out the fallacy in that test:

> It is our view that the point of novelty test is logically unsound. According to this test, a process containing both "physical steps" the statutory portion and so-called "mental steps" the nonstatutory portion constitutes statutory subject matter if the "alleged novelty or advance in the art resides in" steps deemed to be "physical" and nonstatutory if it resides in steps deemed to be "mental." It should be apparent, however, that novelty and advancement of an art are irrelevant to the determination of whether the nature of a process is such that it is encompassed by the meaning of "process" in 35 U.S.C. 101. Were that not so, as it would not be if (the point of novelty test) were the law, a given process including both "physical" and "mental" steps could be statutory during the infancy of the field of technology to which it pertained, when the physical steps were new, and non-statutory at some later time after the physical steps became old, acquiring prior art

> status, which would be an absurd result. Logically, the identical process cannot be first within and later without the categories of statutory subject matter, depending on such extraneous factors. (Id. at 889).

109 Supra at 60.

110 Among the others were In re Comstock, 481 F.2d 905 (CCPA 1973); In re Knowlton,481 F.2d, 1357 (CCPA 1973).

111 In re Waldbaum, supra at 22; In re Richman, 563 F.2d 1026, (CCPA 1977), In re De Castelet, 562 F.2d 1236 (CCPA 1977); Also see In re Christensen, supra at 64.

112 In re Deutsch, 553 F.2d 689 (CCPA 1977); In re Flook, supra at 60. Also see In re Johnston, supra at 106.

113 Other rejections were made under 35 USC 112, that the claims were indefinite, and under 35 USC 103, that the claimed invention was obvious to one of ordinary skill in the art. A rejection that banking is a social science and therefore not a technological art which is patentable was added by the PTO Board of Appeals.

114 Supra at 60.

115 Supra at 61.

116 Supra, 61 at 585.

117 Id. at 586. Claim 1 of Flook reads.

> 1. A method for updating the value of at least one alarm limit on at least one process variable involved in a process comprising the catalytic chemical conversion of hydrocarbons wherein said alarm limit has a current value of
>
> Bo + K
>
> wherein Bo is the current alarm base and K is a predetermined alarm offset which comprises: (1) Determining the present value of said process variable, said present value being defined as PVL; (2) Determining a new alarm base, B1, using the following equation,
>
> B1=Bo (1.0-F) + FVL (F)
>
> where F is a predetermined number greater than zero and less than 1.0;
> (3) Determining an updated alarm limit which is defined as B1 and K; and thereafter
> (4) Adjusting said alarm limit to said updated alarm limit value.

118 The Acting Commissioner of the Patent and Trademark Office stated that the CCPA decision would have a debilitating effect on the software industry and would require the Office to handle thousands of additional patent applications. 437 U.S. at 587.

119 By considering the algorithm in the "prior art" the Court interjected considerations of novelty and/or obviousness under 35 USC 102 and 35 USC 103. This tended to obfuscate the issues. In Nickola v. Peterson

580 F.2d 898 (6th Cir. 1978) decided one day after the Supreme Court decision in Flook, Judge Marky of the CCPA sitting by designation repudiated any consideration of novelty in considering 35 USC 101.

120 462 F. Supp. 135 (D.D.C. 1978), Aff'd without opinion, Hirschfeld v. Banner, 615 F.2d 1368 (1980), cer't den., Diamond v. Hirschfeld, 101 S. Ct. 1695 (1981).

121 588 F.2d 1330 (CCPA 1978).

122 Supra at 64.

123 Supra at 54.

124 Supra 1 and 2. Also see In re Sherwood, Supra at 64 and Hirschfeld v. Banner, Supra at 120.

125 595 F.2d 32 (CCPA 1979).

126 Arshal v. United States, 202 U.S.P.Q. 749 (Ct. Cls. Tr. Div. 1979), 49 U.S.L.W. 3744, April 6, 1981.

127 35 USC 271. Infringement of Patent

(a) Except as otherwise provided in this title, whoever without authority makes, uses or sells any patented invention, within the United States during the term of the patent therefor, infringes the patent.

(b) Whoever actively induces infringement of a patent shall be liable as an infringer.

(c) Whoever sells a component of a patented machine, manufacture, combination or composition, or a material or apparatus for use in practicing a patented process, constituting a material part of the invention, knowing the same to be especially made or especially adapted for use in an infringement of such patent, and not a staple article or commodity of commerce suitable for substantial noninfringement use, shall be liable as a contributory infringer.

(d) No patent owner otherwise entitled to relief for infringement of a patent shall be denied relief or deemed guilty of misuse or illegal extension of the patent right by reason of his having done one or more of the following: (1) derived revenue from acts which if performed by another without his consent would constitute contributory infringement of the patent; (2) licensed or authorized another to perform acts which if performed without his consent would constitute contributory infringement of the patent; (3) sought to enforce his patent rights against infringement or contributory infringement.

128 U.S. Patent No. 3,319,052, issued May 9, 1967.

129 202 U.S.P.Q. 812 (CCPA 1979).

130 A "protective" petition for writ of certiorari was filed by the PTO at the suggestion of the Justice Department in In re Sherwood, supra at 64. A petition for writ of certiorari was also filed by the PTO in Diamond v. Hirschfeld, supra at 120. The claimed invention in Sherwood was directed to a method for mathematically converting a seismic time section into a seismic depth section using a computer implemented algorithm.

131 In re Philips, 608 F.2d 879 (CCPA 1979); In re Walter 618 F.2d 758 (CCPA 1980).

APPENDIX A2 - PART 3
relating to
SECTION III -- SOFTWARE RELATED INVENTIONS
Patentability: Past to Present

Manual of Patent Examining Procedure
New Section 2110
"MATHEMATICAL ALGORITHMS OR COMPUTER PROGRAMS"

The U.S. Supreme Court decisions in Diamond v. Diehr, 450 U.S. 175, 209 USPQ 1 (1981) and Diamond v. Bradley, 450 U.S. 381, 209 USPQ 97 (1981) significantly affect an examiner's analysis under 35 U.S.C. 101 of patent applications involving mathematical equations, mathematical algorithms and computer programs.

In 35 U.S.C. 101, Congress has set forth the categories of inventions or discoveries which may be patentable as consisting of "any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof." Inventions involving mathematical equations, mathematical algorithms or computer programs, if statutory at all, would fall into the categories of statutory subject matter as processes, machines or manufactures. In construing 35 U.S.C. 101, the Supreme Court in Diamond v. Diehr. 450 U.S. 175, 209 USPQ 1, 6 (1981) and Diamond v. Chakrabarty, 447 U.S. 303, 206 USPQ 193 (1980), has applied a broad interpretation to statutory subject matter as "to include anything under the sun that is made by man."

The Supreme Court also reiterated that certain categories of inventive activity should not be considered statutory subject matter. As set forth in Diamond v. Diehr, 209 USPQ 1, 7 (1981), "Excluded from such patent protection are laws of nature, physical phenomena, and abstract ideas." Citing Parker v. Flook, 437 U.S. 584, 198 USPQ 193 (1978); Gottschalk v. Benson, 409 U.S. 63, 175 USPQ 673 (1972). A "scientific truth, or the mathematical expression of it, is not a patentable invention," Mackay Radio Corp. & Telegraph Co. v. Radio Corp. of America, 306 U.S. 86, 94, 40 USPQ 199, 202 (1939). In Gottschalk v. Benson, supra, the Court concluded that an "algorithm, or mathematical formula, is like a law of nature, which cannot be the subject matter of a patent." Similarly, the Court in Parker v. Flook, supra, held that an improved "method for computing 'an alarm limit'," where the application "did not purport to explain how the variables used in the formula were to be selected, nor did the application contain any disclosure relating to the chemical processes at work or the means of setting off an alarm or adjusting the alarm limit" is unpatentable subject matter under 35 U.S.C. 101. (See Diamond v. Diehr, 209 USPQ 1, 10 (1981)).

If the claims of an application are directed solely to one of the above judicially excluded areas of inventive activity, it is clear that a patent shall not issue. However, a claim is not unpatentable under 35 U.S.C. 101 merely because it includes a step(s) or element(s) directed to a law of nature, mathematical algorithm, formula or computer program so long as the claim as a whole is drawn to subject matter otherwise statutory. In this regard, the following significant points of law may be gleaned from the Diamond v. Diehr 209 USPQ 1 (1981) decision:

1. The "claims must be considered as a whole. It is inappropriate to dissect the claim into old and new elements and then to ignore the presence of the old elements in the analysis.". . ."The 'novelty' of any element or steps in a process, or even of the process itself, is of no relevance in determining whether the subject matter of a claim falls within the 101 categories of possibly patentable subject matter." (Emphasis added.)

2. "When a claim containing a mathematical formula implements or applies that formula in a structure or process which, when considered as a whole, is performing a function which the patent laws were designed to protect (e.g., transforming or reducing an article to a different state or thing), then the claim satisfies the requirements of Section 101."

3. "When a claim recites a mathematical formula (or scientific principle or phenomenon of nature), an inquiry must be made into whether the claim is seeking protection for that formula in the abstract." (If the claim does seek protection for such a mathematical formula, it would be non-statutory under 35 U.S.C. 101.)

4. "A mathematical formula as such is not accorded the protection of our patent laws,. . .and this principle cannot be circumvented by attempting to limit the use of the formula to a particular technological environment.". . ."Similarly, insignificant post solution activity will not transform an unpatentable principle into a patentable process."

5. When a claim as in Parker v. Flook, 198 USPQ 193 (1978), is drawn "to a method for computing an 'alarm limit' (which) is simply a number," the claim is non-statutory under 35 U.S.C. 101 because Flook "sought to protect a formula for computing this number."

6. "It is now commonplace that an application of a law of nature or mathematical formula to a known structure or process may well be deserving of patent protection." Citing Funk Bros. Seed Co. v. Kalo Co., 333 U.S. 127, 76 USPQ 280 (1948); Eibel Process Co. v. Minnesota and Ontario Paper Co., 261 U.S. 45 (1923); Cochrane v. Deener, 94 U.S. 780 (1876); O'Reilly v. Morse, 15 How. 62 (1853); and LeRoy v. Tatham, 14 How. 156 (1852).

35 USC 101 CLAIM ANALYSIS

In determining eligibility for patent protection under 35 U.S.C. 101, the Supreme Court in Diamond v. Diehr, 209 USPQ 1 (1981), required that the "claims must be considered as a whole." Consistent with this requirement, the Court concluded that "a claim drawn to subject matter otherwise statutory does not become nonstatutory simply because it uses a mathematical formula, a computer program, or digital computer." Thus, the fact that a claim specifies that a computer performs certain calculation steps is irrelevant for the purpose of determining whether statutory subject matter has been recited. The fact that an application discloses that a mathematical formula is implemented solely by computer programming is likewise immaterial for this purpose.

The Court's requirement that the "claims must be considered as a whole" in effect leaves viable the CCPA's two-step procedure set forth in In re Freeman, 197 USPQ 464, (CCPA, 1978), as an appropriate test for determining if a claim involving mathematics and/or computer programming is in compliance with 35 U.S.C. 101. See also In re Walter, 205 USPQ 397 at 407 (CCPA, 1980) for clarification of the second Freeman step. In accordance with the first step of such an analysis, each method or apparatus claim must be analyzed to determine whether a mathematical algorithm is either "directly" or "indirectly" recited. If the claim at issue fails to directly recite a mathematical algorithm, reference must be made to the specification in order to determine whether claim language indirectly recites mathematical calculations, formulas, or equations.

If a given claim directly or indirectly recites a mathematical algorithm, the second step of the analysis must be applied. Under this step, a determination must be made as to whether the claim as a whole, including all its steps or apparatus elements, merely recites a mathematical algorithm, or method of calculation. If so, the claim does not recite statutory subject matter under 35 U.S.C. 101.

The Supreme Court in Diamond v. Diehr, 209 USPQ 1 (1981), provides some guidance in determining whether the claim as a whole merely recites a mathematical algorithm or method of calculation. The Court suggests that if "a claim containing a mathematical formula implements or applies that formula in a structure or process which, when considered as a whole, is performing a function which the patent laws were designed to protect (e.g., transforming or reducing an article to a different state or thing), then the claim satisfies the requirements of Section 101." (Emphasis added.)

Focusing on the application or implementation of a mathematical algorithm, the Supreme Court in Diehr, 209 USPQ 1 at 89 (1981), citing Mackay Radio Corp. and Telegraph Co. v. Radio Corp. of America, 306 US 86, 94, 40 USPQ 199, 202 (1939), explained that "while a scientific truth, or the mathematical expression of it, is not a patentable invention, a novel and useful structure created with the aid of a scientific truth may be." In this regard, the CCPA noted in In re Walter, 205 USPQ 397 at 407, (CCPA, 1980), that "If it appears that the mathematical algorithm is implemented in a specific manner to define structural relationships between the physical elements of the claim (in apparatus claims) or to refine or limit claim steps (in process claims), the claim being otherwise statutory, the claim passes muster under Section 101."

The Supreme Court in Diehr also indicated that "insignificant post-solution activity will not transform an unpatentable principle into a patentable process." The claims in Parker v. Flook, which were held to be non-statutory, recited a post-solution activity of updating a number, i.e., an alarm limit, a step relating more to a method of calculation than to the physical process alluded to in the claim preamble. In Diehr, the Supreme Court characterized the post-calculation activity of the type claimed in Parker v. Flook as being "token post-solution activity." In contrast, the post-solution activity in the Diehr claims consisted of automatically opening a rubber molding press, a step clearly tied in with the physical process of rubber molding. As stated by the CCPA in In re Walter, 205

USPQ 397 at 407, (CCPA, 1980) "if the end-product of a claimed invention is a pure number, as in Benson and Flook, the invention is non-statutory regardless of any post-solution activity which makes it available for use by a person or machine for other purposes."

It must also be recognized that even though a claim contains an application limiting preamble, even though it does not cover every conceivable application of a formula, or even though it does not totally preempt the formula, such a claim would be non-statutory, if, when considerd as a whole, it merely recites a mathematical algorithm or method of calculation. As stated by the Supreme Court in Diehr, 209 USPQ 1 at 10, (1981), "A mathematical formula does not suddenly become patentable subject matter simply by having the applicant acquiesce to limiting the reach of that formula to a particular technological use." Similarly, the CCPA pointed out in Walter, 205 USPQ 397 at 409 (1981) that "Although the claim preambles relate the claimed invention to the art of seismic prospecting, the claims themselves are not drawn to methods of or apparatus for seismic prospecting; they are drawn to improved mathematical methods for interpreting the results of seismic prospecting. The specific end use recited in the preambles does not save the claims from the holding in Flook, since they are drawn to methods of calculation, albeit improved. Examination of each claim demonstrates that each has no substance apart from the calculations involved."

Also, in Walter, a Jepson preamble was not regarded as limiting the "subject matter as a whole," so as to avoid the Section 101 rejection. Similarly, preliminary data gathering steps may not affect the "subject matter as a whole" assessment. In re Richman, 195 USPQ 340, (CCPA 1977). Moreover, even the concluding step of building a bridge or dam may not suffice. In re Sarker, 200 USPQ 132 (CCPA, 1978). In other words, for purposes here, the "subject matter as a whole" must be viewed in context on a case by case basis. In analyzing computer program related claims, it is essential to recognize that computer implemented "processes are encompassed within 35 U.S.C. 101 under the same principles as other machine implemented processes, subject to judicially determined exceptions, inter alia, mathematical formulas, methods of calculation, and mere ideas." In re Johnson et al, 200 USPQ 199 at 210, 211 (CCPA, 1978). In accordance with the two-step procedure outlined above, claims seeking coverage for a computer program would be non-statutory under 35 USC 101, only if, when considered as a whole, they merely recite a mathematical algorithm, or a method of calculation. Such an approach is the same as that contemplated for apparatus claims by the CCPA in In re Bradley and Franklin, 202 USPQ 480 (CCPA, 1979).

Certain computer program related claims may be non-statutory under 35 U.S.C. 101 as falling within judicially determined exceptions outside the mathematics area. For example, consider the following claims:

1) "A computer program comprising the steps of:
   a) associating treatment rendered to a patient with a fee, and
   b) billing said patient in accordance with the fee."

Here the computer program is claimed, not in terms of a specific instruction set, but alternatively as a series of steps broadly defining what the program is designed to accomplish. Such a claim should be viewed as non-statutory under 35 U.S.C. 101 as reciting a method of doing business.

2) "A computer program for comparing array A(N) with array B(M) to generate array C comprising the steps of:

```
  . . .
Do 70 N = 1, 10
   Do 80 M = 1, 20
    If A(N) = B(N) then C(M) = B(M)
   80 Continue
70 Continue
          . . . ."
```

This bare set of instructions fails to recite subject matter that falls within any statutory category. In this regard, a bare set of computer instructions does not set forth a sequence of steps which could be viewed as a statutory process. Such a computer language listing of instructions, when not associated with a computing machine to accomplish a specific purpose, would not constitute a machine implemented process, but would constitute non-statutory subject matter as the mere idea or abstract intellectual concept of a programmer, or as a collection of printed matter.

Further guidance on handling 35 U.S.C. 101 issues may also be gleaned from the CCPA's detailed claim analysis in the following decisions: In re Chatfield, 191 USPQ 730 (CCPA, 1976); In re Johnson, Parrack and Lundsford, 200 USPQ 199 (CCPA, 1979); In re Sarker, 200 USPQ 132 (CCPA, 1978); In re Gelovatch and Arell, 201 USPQ 136 (CCPA, 1979); In re Bradley and Franklin, 202 USPQ 480 (CCPA, 1979); In re Walter, 205 USPQ 397 (CCPA, 1980).

In addition to handling 35 U.S.C. 101 issues in accordance with the above analytical approach, it should be emphasized that examiners must also carefully examine mathematical algorithm or computer programming related applications to insure that they comply with the disclosure requirements of Section 112 as well as the novelty and unobviousness requirements of Sections 102 and 103.

* * *

APPENDIX B

OBTAINING PREVIOUS OTAF PUBLICATIONS**

Copies of the previous OTAF publications listed below are available from:

National Technical Information Service (NTIS)
5285 Port Royal Rd.
Springfield, Virginia 22161
(703) 487-4650

When ordering from NTIS, please give the publication title and its "COM" or "PB" number.

1. Initial Publication, May 1973
   COM 73-10767; Cost: Domestic - $11.00 Foreign - $22.00
   Describes OTAF program and gives sample reports on 24 wide ranging areas of technology in varying levels of detail.

2. Early Warning Report, December 1973
   COM 74-10150; Cost: Domestic - $21.50 Foreign - $43.00
   Spotlights those technological areas experiencing a high level of overall activity or of foreign activity. Reviews patent activity in a number of energy areas, including nuclear; solar; geothermal; and tide, wind and wave energy.

3. Third Report, June 1974
   COM 74-11383; Cost: Domestic - $15.50 Foreign - $31.00
   Presents an overview of the technological activity, across all technologies, of a group of selected foreign countries and a group of selected U.S. states. Extends energy area treatments to include oil shale and coal gasification technologies. Reviews additional high overall activity technological areas.

4. Fourth Report: A Review of Patent Ownership, January 1975
   COM 75-10050; Cost: Domestic - $12.50 Foreign - $25.00
   Identifies the 73 corporations and government agencies which received 500 or more patents during the five year period 1969-1973, and reviews and compares their patent activity across the spectrum of technology. Also reviews in terms of patent ownership, the patent activity during the same period, in nuclear energy technology and oil shale and coal gasification technology.

5. Fifth Report, August 1975
   COM 75-11142; Cost: Domestic - $14.00 Foreign - $28.00
   Reviews 60 technological areas, not previously reported on, experiencing a high level of overall activity or of foreign activity. Presents patent activity data in categories corresponding to 36 Product Fields of the Standard Industrial Classification System.

** SPECIAL NOTE: NTIS AND GPO PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE.

6. Sixth Report, June 1976
PB 254188; Cost: Domestic - $15.50 Foreign - $31.00
Reviews 15 technologies with unusually high activity by foreign resident inventors, and 22 high overall activity technologies; updates the 1973 reports on patent activity in solar and other natural energy sources, and adds reports on the use of waste material and wind for energy generation. Presents comparisons of patenting to R&D expenditures and R&D manpower allocations in six selected industries. The report concludes with a review of six most often cited patents in 1975, 5 U.S. and 1 foreign patent.

7. Seventh Report, March 1977*
PB 265792; Cost: Domestic - $17.00 Foreign - $34.00
Reviews historical patenting and trademark registration trends, and includes the most extensive collection of historical U.S. patent data ever presented in a single publication. Makes first use in the series of data relating to patents granted by foreign nations for a study of invention sources. Makes first use in the series of pending patent application data for forecasting. Presents brief reviews of 16 technologies experiencing high overall or foreign patent activity. Concludes with the series' most comprehensive assessment of activity in a given technology, specifically in computer memories.

8. Eighth Report, December 1977*
PB 276375; Cost: Domestic - $12.50 Foreign - $25.00
Reviews U.S. patenting in the context of domestic vs. international patenting and analyzes the balance of patenting between the U.S. and other countries. Presents a study demonstrating the uniqueness of patents and the patent file as a technological resource. Concludes with an in-depth analysis of patent activity in geophysical exploration for hydrocarbons.

9. Ninth Report, March 1979*
PB 293380; Cost: Domestic - $15.50 Foreign - $31.00
Reviews "Top Fifty" most active technologies (U.S.P.C. subclasses) in three categories -- Most Active, Fastest Growing, and Most Foreign-Active -- for each of three broad groupings of technology -- Chemical, Electrical and Mechanical. Examines trends in domestic patenting and independent inventor patenting. Includes an extensive review of patenting in "Ferrous Metal" technologies. Concludes with a discussion of two experiments in the transfer of "appropriate technology" to small businesses and developing countries.

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PATENT PROFILE SERIES

1. PATENT PROFILES-Synthetic Fuels, December, 1979*
PB 80128572; Cost: Domestic - $6.50 Foreign - $13.00

Profiles the patent activity in ten specific areas of synthetic fuel technology dealing with the conversion of solid carbonaceous material to liquid or gaseous hydrocarbons. Starting materials include coal, oil shale, bituminous sands, wood and organic wastes.

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*Also available from the Government Printing Office -- see page 160.

2. PATENT PROFILES-Solar Energy, January 1980*
PB 80190010; Cost: Domestic - $6.50 Foreign - $13.00

Profiles the patent activity in five specific areas directed to energy provided by the sun and in three areas directed to energy derived from other natural sources, such as wind, tide, wave, and geothermal. A cumulative profile of the five solar areas illustrates the dramatic growth in this field.

3. PATENT PROFILES-Microelectronics - I, February, 1981*
PB 81-179582; Cost: Domestic - $8.50 Foreign - $17.00

Profiles the patenting activity in two representative segments of microelectronics technology relating to integrated circuit structure and information processing devices, e.g., "CPU's". Profiles of patenting in other areas of this diverse technology are planned for future issues.

NTIS Microfilm of Previous Reports
Domestic - $3.50 per report; Foreign - $5.25 per report

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Industrial Patent Activity in the United States, Part 1 and 2, April, 1981
PB81-207847; Cost: Domestic - $50.50

This two-part publication identifies those U.S. and foreign organizations, e.g. corporations, government agencies and universities, which have been most active in the U.S. Patent System during the year 1969-1980. Yearly editions of this publication are expected. Each part described below may be purchased separately.

Part 1 - Time Series Profile by Company, April, 1981
PB81-170714; Cost: Domestic - $36.50

Part 1 identifies companies having 10 or more patents in the 1969-1980 period. These patent recipients are ranked in terms of total 12-year patent receipts, and patent activity for each year is profiled by both patent grant date and patented application filing date. A preliminary portion of this report presents a statistical overview of the relative activity of all nations which are active in the U.S. Patent System, as well as that of corporate, government and individual inventors.

Part 2 - Alphabetical Listing by Company, April, 1981
PB81-170722; Cost: Domestic - $25.50

Part 2 is an alphabetical list of more than 18,000 U.S. and foreign organizations receiving at least three patents during the period 1969-1980. Included for each organization is the total patent count for the 12-year period.

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*Also available from U.S. the Government Printing Office -- see page 160.

*NOTE:

The following publications may also be obtained from:

The Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402.

Their identification numbers and cost are:

. Seventh Report, 003-004-00542-4; Cost: Domestic - $4.25;

. Eighth Report, 003-004-00550-5; Cost: Domestic - $3.75;

. Ninth Report, 003-004-00559-9; Cost: Domestic - $4.00;

. PATENT PROFILES-Synthetic Fuels, 003-004-00566-1; Cost: Domestic - $5.50;

. PATENT PROFILES-Solar Energy, 003-004-00568-8; Cost: Domestic - $5.50;

. PATENT PROFILES-Microelectronics - I, 003-004-00574-2;
Cost: Domestic - $7.00.

APPENDIX C

OBTAINING ADDITIONAL INFORMATION OR SPECIAL CUSTOM REPORTS

Background

OTAF's computerized base of data relating to the patent file includes, at present:

- all subclasses of the U.S. Patent Classification System
- the relationship of all subclasses of the U.S. Patent Classification System to the Standard Industrial Classification System in 55 Product Fields and Product Field combinations
- for U.S. patents issued since 1963,
  - . the ownership at time of issue in 7 categories (U.S. government, foreign government, U.S. corporation, foreign corporation, U.S. individual, foreign individual, and unassigned)
  - . the country or state of residence of the inventor
- for U.S. patents issued since 1967,
  - . the date the application for patent was filed in the U.S.
- for U.S. patents issued since 1969,
  - . the specific (i.e. named) ownership of all patents which, at time of issue, were organizationally owned (e.g., by a corporation, foundation, government agency).
  - . the patent title
- for U.S. patents issued since 1975,
  - . the name and address of inventors of unassigned patents
  - . the field of search and references cited in the examination leading to the patent grant.

Special Custom Reports

Data can be retrieved on the basis of any one or any combination of the factors listed above, manipulated on most any given basis and presented in a number of formats, e.g., lists, tables, graphs, charts, etc. This flexibility is illustrated by the various types of reports presented in the series of Technology Assessment and Forecast Reports, the PATENT PROFILES publications and by the excerpts of reports which follow.

OTAF has developed several standard Special Custom Report programs which are designed to extract and present, for any given grouping of patents, a wide variety of data. Excerpts from samples of reports prepared using these programs begin on page 164.

STANDARD FORMAT OTAF SPECIAL REPORTS

"Technology Profile" Report

This is a multi-part report, utilizing most of the elements in OTAF's data base to provide a detailed patent profile for a specific technology or grouping of technologies. Information provided includes rate of patenting, origin of patenting, type of assignment and specific assignment, patent numbers and their titles, and names and addresses of "independent" inventors. There are four parts (parts A,B,C,& D) which comprise a complete report. Part A includes patent activity percentages, general assignment and distribution by origin of patents; Part B includes, by assignee, the number of patents granted by both year of application filing and grant date, ranked by assignee with highest number of patents; Part C includes, alphabetically, the assignees and their specific patent numbers and titles; Part D gives the name and address of the inventors of patents unassigned at time of issue. Any Part can be prepared depending on your needs. Sample pages from a report of this type and an "Explanation of Data," giving an overview of what is included, begin on page 164. The pages are excerpts from a report on "Pacemakers" for the years 1963-1980.

"Organizational Profile" Report

Beginning on page 170 are excerpts from the second of OTAF's standard format reports. The sample report profiles the patent activity across the classes and subclasses of the U.S. Patent Classification System. Organizational Profiles can also be limited to specific classifications. A report for A.O. Smith Corporation is given as an example. Two pages of the 38 page report are included. This type of report can be prepared, for example on the patents of any organization or grouping of organizations, or on the patents granted to the residents of any state or country or grouping of states or countries.

SIC Product Field Reports

On pages 172-174 is a listing of Standard Industrial Classification (SIC) Product Fields for which a concordance exists with subclasses of the U.S. Patent Classification System. Special patent reports, such as the "Technology Profile" Report can be prepared for any of these Product Fields.

Other Standard Format Reports

OTAF is now in the process of developing other standard formats designed to meet the needs of a large number of report users. These include: Organizational Patenting where patents of the designated organization are given in numerical order; Enterprise Patenting where the number of patents per year per class is given for a parent company and its patenting subsidiaries; Search and Citation Reports which include, for a designated classification or group of classifications, the number and origin of the references cited during the examination period leading to the grant of the patent, the U.S. references most frequently cited and the owner (assignee) of patents most frequently cited.

How to Obtain OTAF Special Reports

- Contact OTAF to discuss the type of information you need.
- OTAF will assist you in determining the report content and format that best suits your needs, and provide you with a free estimate of its cost.
- If the terms are acceptable to you, the report will be prepared and forwarded to you. Standard format reports are usually available within 5 working days.

Costs

All Special Reports are prepared on a cost reimbursable basis and billed through the National Technical Information Service to which payment is made by check, or charged to an NTIS deposit account or major credit card. These costs may vary widely -- from as low as $100.00 for some forms of our standard format reports, to several thousand dollars for complex and large scale treatments of many technological categories, requiring extensive professional time, programming and/or computer time. Cost estimates for specifically requested special reports will be provided prior to report preparation.

Whom to Contact

Inquiries concerning OTAF publications/services are invited and should be directed to:

Office of Technology Assessment
and Forecast
U.S. Patent and Trademark Office
Washington, D.C. 20231
Phone: (703) 557-2982

EXPLANATION OF DATA

Description of Recent Activity

In each standard report, patent activity is profiled from 1963-1980. Reports can be limited to fewer years.

Each report begins with an "Activity Indicies" table. The table represents for the area, information as to the:

- Average Percent Growth, number of patents issued in the period 1978-80 divided by the total number of patents in the period 1971-80.

- Average Percent Foreign, the number of patents issued to residents of foreign countries in the years 1978-80 divided by total number of patents issued in these years.

- Average Percent Corporate Owned, the number of 1978-80 patents assigned at time of issue to U.S. or foreign non-government organizations -- mainly corporations -- divided by the total number of patents issued in this three year period.

- Average Percent Government Owned, the number of 1978-80 patents assigned at time of issue to the U.S. or a foreign government divided by total number of patents issued in this three year period.

- Average percent U.S. Owned of Foreign, the number of 1978-80 patents with a foreign resident inventor that are assigned to a U.S. organization, divided by the number of patents with a foreign resident inventor in these years.

- XR/OR Ratio, the number of 1978-80 patents with a cross reference designation, divided by the number of patents with an original (primary) designation.

TABLES

In the 2nd through 5th pages of each active area report, tables are presented showing by number and percent the patent activity in the area from 1963 through 1980 - first by date of patent grant (2nd and 3rd pages) and then by date of application filing for patents granted from 1967-1980 (4th and 5th pages).

Each of these tables presents the data in several ways:

.Total
.U.S. Origin - inventor a U.S. resident
.Foreign Origin - inventor a foreign resident

The foreign origin data are further subdivided by the country of inventor residence. Data breakdown based on patent ownership is also given both for the U.S. origin and the foreign origin patents.

Distributing 1967-1980 patents on an application date basis provides essentially complete data on those applications, which ultimately became patents, filed each year from 1965 through 1978. This is the case because there is a delay between the filing of a patent application and its subsequent issuance as a patent. The length of this delay (i.e., the "pendency" of an application) is determined by many factors, including Patent and Trademark Office workload (which varies between technologies), budget and manpower levels, patent printing schedules, etc.

In 1967, when maintainance of application date data in machine readable form began (and thus became subsequently available for inclusion in the OTAF data base) the average patent pendency was substantially in excess of two years. Consequently, patent applications filed in 1965 and 1966 were not issuing as patents until 1967 or later.

By December of 1977, as a result of an ambitious and successful Patent and Trademark Office program, the average pendency had been reduced to about 19 months. The current average pendency of 22 months renders the patents by application date data shown for years subsequent to 1978 (i.e., 1979-1980) incomplete. The obvious reason for this is that a significant number of the applications filed in 1979 and 1980 were still pending and, therefore, were not reflected in the OTAF data base at the time of the 1980 update.

It should be noted that only applications which ultimately matured into patents are reflected in the application date data. Those applications which were filed but never issued (roughly 30% of total filings) are not included.

OTAF feels that the application date data are of significant value, for the date an application is filed is a more accurate reflection of when the technology was developed. Additionally, fluctuation in data based on application date is much more likely to reflect changes in technological activity, since such fluctuation would, for the most part, be immune from, rather than the result of changes in Patent and Trademark Office application processing.

FOR EXAMPLE, the 1979 patent grant data may be low, not because of a fall-off in technological activity, but rather due to the fact that in 1979, the Patent and Trademark Office issued substantially fewer patents than normal (about 49,000 as compared to about 66,000 in 1978) due to a lack of funds to print patents.

Following the tables, in Part B of the report, is a distribution of organizational patenting by patent assignees having received, from January 1969 through December 1980, a number of patents equal to or greater than a given "cut-off" number. This patenting is given, by year, both by patent grant date and by patent application date. In Part C of the report, the specific patent numbers and titles are listed, by assignee. In Part D, inventor names, addresses, patent numbers and titles are given for unassigned 1975-1980 patents. Patents with neither assignment nor inventor information in the data base are given last.

The user should be aware that patent activity profiles are generated by first identifying key Patent and Trademark Office classifications, i.e., those entirely or substantially pertinent to the technology of interest. All the patents in these classifications are included in the profile. This procedure results, in most cases, with the inclusion of the majority of patents relevant to the technology and few, if any, non-relevant patents. However, any patent listing provided should not be considered to be inclusive of all relevant patents, nor exclusive of all non-relevant patents.

OTAF SPECIAL REPORT - PACEMAKERS

PATENT ACTIVITY (1963-1980) BY DATE OF PATENT GRANT

NUMBER OF PATENTS

	63-66	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL	1	1		1	1	4	6	14	14	35	24	26	28	30	31	216
U.S. ORIGIN	1	1		1	1	3	5	12	10	29	17	19	23	27	25	174
FOREIGN ORIGIN						1	1	2	4	6	7	7	5	3	6	42
NETHERLANDS												5	2	1		8
UNITED KINGDOM									1	2	1		1		2	7
WEST GERMANY										2	1		2		2	7
FRANCE								1	3		1	1				6
SWEDEN										2				1		3
AUSTRALIA											3					3
ARGENTINA											1					1
ITALY												1				1
JAPAN														1		1
U.S.S.R.															1	1
CANADA						1									1	1
SPAIN																1
DENMARK								1								1
SWITZERLAND							1									1
U.S. ORIGIN	1	1		1	1	3	5	12	10	29	17	19	23	27	25	174
U.S. CORP. OWNED	1	1		1	1	3	4	11	9	22	17	19	20	19	20	148
U.S. GOVT. OWNED									1							1
U.S. INDIV. OWNED							1	1		6			3	4	1	16
FOREIGN OWNED										1				4	4	9
FOREIGN ORIGIN						1	1	2	4	6	7	7	5	3	6	42
U.S. OWNED								1								1
FOREIGN OWNED						1	1	1	4	6	7	7	5	3	6	41
FOREIGN CORP.							1	1	1	5	4	6	3	2	3	26
FOREIGN GOVT.													1			1
FOREIGN INDIV.						1			3	1	3	1	1	1	3	14

OTAF SPECIAL REPORT - PACEMAKERS

PATENT ACTIVITY (PATENTS GRANTED 1/67-12/80) BY DATE OF PATENT APPLICATION

NUMBER OF PATENTED APPLICATIONS

	PRE 67	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
TOTAL	2	1	3	3	7	13	14	16	29	25	31	33	34	4		215
U.S. ORIGIN	2	1	2	2	6	10	11	13	24	16	29	27	27	3		173
FOREIGN ORIGIN			1	1	1	3	3	3	5	9	2	6	7	1		42
NETHERLANDS										4	1	1	2			8
UNITED KINGDOM					1		1	1	1			1	2			7
WEST GERMANY									2	1		2	2			7
FRANCE						2	2		1	1						6
SWEDEN								2				1				3
AUSTRALIA									1	2						3
ARGENTINA										1						1
ITALY											1					1
JAPAN												1				1
U.S.S.R.														1		1
CANADA			1													1
SPAIN													1			1
DENMARK						1										1
SWITZERLAND				1												1
U.S. ORIGIN	2	1	2	2	6	10	11	13	24	16	29	27	27	3		173
U.S. CORP. OWNED	2	1	2	2	5	9	9	10	21	16	28	22	17	3		147
U.S. GOVT. OWNED							1									1
U.S. INDIV. OWNED					1	1	1	2	3		1	4	3			16
FOREIGN OWNED								1				1	7			9
FOREIGN ORIGIN			1	1	1	3	3	3	5	9	2	6	7	1		42
U.S. OWNED						1										1
FOREIGN OWNED			1	1	1	2	3	3	5	9	2	6	7	1		41
FOREIGN CORP.				1	1	1	1	3	2	7	2	3	5			26
FOREIGN GOVT.												1				1
FOREIGN INDIV.			1			1	2		3	2		2	2	1		14

OTAF SPECIAL REPORT - PACEMAKERS

ORGANIZATIONAL PATENTING (1/69-12/80) -- ORGANIZATIONS WITH 1 OR MORE PATENTS

	PRE 67	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	TOTAL
MEDTRONIC INC.																
PATENTS GRANTED						2		1	2	6	6	6	3	9	11	46
PATENTED APPLICATIONS			1		1	2	1		10	5	7	7	11	1		46
AMERICAN OPTICAL CORPORATION																
PATENTS GRANTED							1	4	2	4	2		3			16
PATENTED APPLICATIONS					1	2	3	2	4	1	1	2				16
ARCO MEDICAL PRODUCTS COMPANY																
PATENTS GRANTED										2	1	4	1	1	3	12
PATENTED APPLICATIONS									1	2	4	3	2			12
BIOTRONIK MESS- UND THERAPIEGERATE GMBH + CO.																
PATENTS GRANTED													1	3	5	9
PATENTED APPLICATIONS												1	8			9
PACESETTER SYSTEMS, INC.																
PATENTS GRANTED										1		2	2		4	9
PATENTED APPLICATIONS								1			4	1	2	1		9
VITATRON MEDICAL B.V.																
PATENTS GRANTED										1		5	2	1		9
PATENTED APPLICATIONS								1		4	1	1	2			9
RESEARCH CORPORATION																
PATENTS GRANTED											3	2	1	2		8
PATENTED APPLICATIONS										5	3					8
GENERAL ELECTRIC COMPANY																
PATENTS GRANTED				1	1			2	1		1	1				7
PATENTED APPLICATIONS	1		1			2	1		1	1						7
CARDIAC PACEMAKERS, INC.																
PATENTS GRANTED									1	1		1	1	2		6
PATENTED APPLICATIONS							1	1			2	2				6
MEDALERT CORPORATION																
PATENTS GRANTED											1	1	2	2		6
PATENTED APPLICATIONS									1	1	3		1			6
MEDCOR INC.																
PATENTS GRANTED								1	1	1			1		1	5
PATENTED APPLICATIONS					1		1	1				1		1		5
SIEMENS AKTIENGESELLSCHAFT																
PATENTS GRANTED										3	1					4
PATENTED APPLICATIONS								2	1	1						4
E.S.B. INCORPORATED																
PATENTS GRANTED								3					1			4
PATENTED APPLICATIONS					1	2					1					4
CORATOMIC INC.																
PATENTS GRANTED										1	1	1		1		4
PATENTED APPLICATIONS								1		1	1	1				4

ASSIGNED PATENTING(1/69-12/80) - - ALPHA LISTING

ADCOLE CORPORATION
- 3683932 - IMPLANTABLE TISSUE STIMULATOR

AMERICAN HOSPITAL SUPPLY CORPORATION
- 3662759 - CARDIAC PACER SYSTEM
- 4114627 - CARDIAC PACER SYSTEM AND METHOD WITH CAPTURE VERIFICATION SIGNAL

AMERICAN OPTICAL CORPORATION
- 3674015 - RATE DISCRIMINATORY ELECTROCARDIO-GRAPHIC MONITORING SYSTEM
- 3746005 - CONSTANT ENERGY HEARTBEAT STIMULATING APPARATUS WITH PULSE WIDTH CONTROL
- 3747604 - ATRIAL AND VENTRICULAR DEMAND PACER WITH SEPARATE ATRIAL AND VENTRICULAR BEAT DETECTORS
- 3756245 - HEARTBEAT STIMULATING APPARATUS INCLUDING MEANS FOR CALIBRATING ITS POWER SUPPLY
- 3759265 - PULSE-WIDTH CONTROLLED HEARTBEAT STIMULATING APPARATUS MONITORING SYSTEM
- 3837348 - EXTERNALLY-CONTROLLED IMPLANTABLE CARDIAC-PACER CAPTURE MARGIN TESTING APPARATUS AND METHOD
- 3841336 - PACER BATTERY FAILURE DETECTION CIRCUIT
- 3877438 - PACER WITH SELF-ADJUSTING OUTPUT
- 3881493 - SYNCHRONOUSLY REINFORCING PACER
- 3885572 - QUICK DISCHARGE CIRCUIT FOR PACER NUCLEAR POWER SUPPLY
- 3906959 - LIQUID LEAK STOP FOR AN IMPLANTABLE HEART PACER
- 3981309 - PATIENT STIMULATING PACER ELECTRODE
- 3986514 - BATTERY FOR USE WITH IMPLANTABLE HEART PACER
- 4091817 - P-WAVE CONTROL, R-WAVE INHIBITED VENTRICULAR STIMULATION DEVICE
- 4102345 - PACER DEMAND-RATE TEST MODE CONTROL
- 4117848 - CARDIAC INSTRUMENTATION APPARATUS WITH PACER DIAGNOSTICS

ARCO MEDICAL PRODUCTS COMPANY
- 3926197 - DEMAND HEART PACER
- 3926198 - CARDIAC PACER
- 3983880 - APPARATUS FOR GENERATING HEART STIMULATION PULSES UPON DEMAND
- 4013081 - PEDIATRIC CARDIAC PACER SYSTEM
- 4038991 - CARDIAC PACER WITH RATE LIMITING MEANS
- 4049003 - DIGITAL CARDIAC PACER
- 4049004 - IMPLANTABLE DIGITAL CARDIAC PACER HAVING EXTERNALLY SELECTIBLE OPERATING PARAMETERS AND "ONE SHOT" DIGITAL PULSE GENERATOR FOR USE THEREIN
- 4126139 - METHOD AND MEANS FOR RECEIVING PARAMETER CONTROL DATA IN AN IMPLANTABLE HEART PACER
- 4164944 - DIGITAL MEANS FOR NON-INVASIVELY CONTROLLING THE PARAMETERS OF AN IMPLANTABLE HEART PACER
- 4181133 - PROGRAMMABLE TACHYCARDIA PACER
- 4190055 - CIRCUIT FOR DETERMINING THE PARAMETER CONTROL STATES OF AN IMPLANTED PACER
- 4192316 - PROGRAMMABLE ATRIO-VENTRICULAR PACER

ARCO NUCLEAR COMPANY
- 3898994 - FIXED-RATE PACER CIRCUIT WITH SELF-STARTING CAPABILITY

ASSOCIATION D RECHERCHE ET D ENTRAIDE
- 3845773 - CARDIAC STIMULATORS

AXOTRONICS INC.
- 3924641 - BI-PHASIC CURRENT STIMULATION SYSTEM

BIOTRONIK MESS- UND THERAPIEGERATE GMBH + CO.
- 4105037 - RELEASABLE ELECTRICAL CONNECTING MEANS FOR THE ELECTRODE TERMINAL OF AN IMPLANTABLE ARTIFICIAL CARDIAC PACEMAKER
- 4169480 - DEMAND PACER WITH PROGRAMMABLE RATE HYSTERESIS
- 4170999 - DEMAND PACER HAVING REDUCED RECOVERY TIME
- 4173230 - NOISE ELIMINATION AND REFRACTORY PERIOD CONTROL IN DEMAND PACERS
- 4202341 - CARDIAC PACEMAKER CIRCUIT WITH VARIABLE OPERATION
- 4202342 - PROGRAMMABLE PACER WITH VARIABLE AMPLIFIER SENSITIVITY AND PACING RATE

UNASSIGNED PATENTS(1/75-12/80) INVENTORS(ALPHA LISTING)

INVENTOR NAME			STREET	CITY	ST	ZIP/CNTRY
ALLEN	KENNETH	ROY	48 WREN ROAD	WELWYN GARDEN CITY,		EN
3942534 - DEVICE FOR TERMINATING TACHYCARDIA						
BARTON	STEVEN	A.	401 S. BRAZOSPORT BLVD.	FREEPORT	TX	77541
4187853 - ELECTRODE IMPLANTING APPARATUS WITH OPTIMUM LOCATION PROBE						
BERNSTEIN	ROBERT	I.	100 DEERFIELD DR.	TENAFLY	NJ	07670
3908667 - CARDIAC PACER						
DAHL	JOSEPH	D.	815 E. 51 ST.	MINNEAPOLIS	MN	55417
4140132 - VARIABLE RATE TIMER FOR A CARDIAC PACEMAKER						
DE BAKKER	JACQUES		MORETTISTR. 54	VAALS		NL
4129133 - INTERFERENCE-DETECTING DEMAND HEART PACEMAKER						
DRESBACH	JAMES	BERNARD	16885 MUIRLAND	DETROIT	MI	48221
3898995 - NONCOMPETITIVE PACEMAKER WITH PROGRAMMABLE UNIJUNCTION TRANSISTORS						
GREATBATCH	WILSON		5220 DONNINGTON RD.	CLARENCE	NY	14031
3870050 - DEMAND PACER						
4135519 - CARDIAC PACER HAVING ALKALI METAL-HALOGEN CELL WITH MIXED HALOGEN CATHODE						
4157720 - CARDIAC PACEMAKER						
IRNICH	WERNER		REIMSER STR. 48	51 AACHEN		DE
4129133 - INTERFERENCE-DETECTING DEMAND HEART PACEMAKER						
KENNY	JOHN		4 HOBB'S WAY	WELWYN GARDEN CITY,		EN
3942534 - DEVICE FOR TERMINATING TACHYCARDIA						
LEHR	SIEGFRIED	R.	8 MUNICH 60	NEGRELLIST 100		DT
3906960 - MEDICAL ENERGY CONVERTER						
MUTO	RUDOLPH		24 WILLIAM ST.	ANDOVER	MA	01810
4169479 - ELONGATED, TAPERED FLEXIBLE FRONT GUIDE FOR ELECTRICAL CATHETERS AND METHOD OF USE						
MUTO	RUDOLPH		24 WILLIAMS ST.	ANDOVER	MA	01810
4094321 - SHALLOW, DOME-SHAPED PACER WITH BOTTOM STORAGE MEANS FOR CATHETER						
PEQUIGNOT	MICHEL		14 VILLA DESIRE FILLEAUD	92140 CLAMART		FR
3939844 - METHOD AND APPARATUS FOR STIMULATING A HEART TO ELIMINATE RHYTHMIC ABNORMALITIES, ESPECIALLY TACHYCARDIAS						
PRESTON	ALBERT	W. JR.	111 OGDEN AVE.	SWARTHMORE	PA	19081
3921642 - AUTOMATIC RATE ADJUSTMENT PACER WITH NATURAL RATE SEARCHING MEANS AND METHOD OF OPERATION						
PRESTON	THOMAS	A.	820 37TH AVE.	SEATTLE	WA	98122
3893461 - PACING APPARATUS AND METHOD UTILIZING IMPROVED CATHETER						
3915174 - PACING APPARATUS AND IMPROVED CATHETER						
3921642 - AUTOMATIC RATE ADJUSTMENT PACER WITH NATURAL RATE SEARCHING MEANS AND METHOD OF OPERATION						
REENSTIERNA	ERIK	G.	BORGEBY 11	230 50 BJARRED		SE
4162679 - METHOD AND DEVICE FOR THE IMPLANTATION OF ONE OR MORE PACEMAKER ELECTRODES IN A HEART						

ORGANIZATIONAL PROFILE

EXPLANATION OF DATA

This report profiles patents falling into a particular "category", by the U.S. patent classifications into which those patents have been placed. The "category" may be a specific ownership (e.g., a specific corporation or government agency) or a country or state of inventor residence. The report may show patents in original classifications only (OR) or in original plus any appropriate cross-reference classifications (OR + XR).

Each major patent classification (class) is identified by its title. Then, for each of the subclasses within that class where patents from the "category" have been placed, the following are given:

--TOTAL (number of "category" patents in subclass)
--OR (number of TOTAL which are original patents)
--XR* (number of TOTAL which are cross-reference patents)
--PCT OF TOTAL OR (number of OR in subclass divided by number of OR patents in "category" x 100)
--PCT OF ALL (OR + XR*) (number of OR + number of XR* in subclass divided by number of OR + XR* patents in "category" x 100)
* Number will be zero if report is limited to OR's.

The above figures are then given for the entire class. Also given are the patent numbers of the "category" patents in each subclass. The type of classification (OR or XR) assigned to each patent is shown in parentheses following the patent number.

For patents issuing in 1969 and subsequently, the patent titles are given. (Note: any symbols in a patent title which are not available on the computer printer are spelled out, e.g., β is shown as BETA. Superscripts and subscripts are indicated by encloser between upwardly or downwardly facing slashes, e.g., H_2O is shown as H/2\O and Y^2X is shown as Y\2/X.)

The patents included in the report are those which according to the data of record in the OTAF computer data base, fall within the category covered in the report. These category data are recorded at the time of patent issue and are essentially accurate. However, any patent listing should not be considered to be inclusive of all relevant patents, nor exclusive of all non-relevant patents.

CLASS 029 - METAL WORKING

SUBCLASS 33 P TOTAL 1 (OR) 0 (XR) 1 PCT OF TOTAL OR 0.0 PCT OF ALL (OR+XR) .2

3612815 (XR) - ELECTRON BEAM APPARATUS

SUBCLASS 155 R TOTAL 1 (OR) 0 (XR) 1 PCT OF TOTAL OR 0.0 PCT OF ALL (OR+XR) .2

3420032 (XR) - LOCKING LANCE TAB PRE-ASSEMBLY OF BOX-SECTION FRAME MEMBER

SUBCLASS 407 TOTAL 1 (OR) 0 (XR) 1 PCT OF TOTAL OR 0.0 PCT OF ALL (OR+XR) .2

3596352 (XR) - METHOD OF CALIBRATING BIMETALLIC ELEMENTS IN A THERMAL OVERLOAD SWITCH

SUBCLASS 453 TOTAL 1 (OR) 0 (XR) 1 PCT OF TOTAL OR 0.0 PCT OF ALL (OR+XR) .2

3420032 (XR) - LOCKING LANCE TAB PRE-ASSEMBLY OF BOX-SECTION FRAME MEMBER

SUBCLASS 527.2 TOTAL 1 (OR) 1 (XR) 0 PCT OF TOTAL OR .7 PCT OF ALL (OR+XR) .2

3465424 (OR) - METHOD OF FORMING GLASS COATED STEEL ARTICLES

SUBCLASS 593 TOTAL 1 (OR) 0 (XR) 1 PCT OF TOTAL OR 0.0 PCT OF ALL (OR+XR) .2

3596352 (XR) - METHOD OF CALIBRATING BIMETALLIC ELEMENTS IN A THERMAL OVERLOAD SWITCH

SUBCLASS 596 TOTAL 5 (OR) 4 (XR) 1 PCT OF TOTAL OR 3.0 PCT OF ALL (OR+XR) 1.1

3512902 (XR) - INDUCTIVE CORE DEVICE AND METHOD OF MAKING THE SAME
3518754 (OR) - METHOD OF MANUFACTURING A MOTOR STATOR ASSEMBLY
3742595 (OR) - METHOD OF MANUFACTURING A SUBMERSIBLE MOTOR
3821846 (OR) - METHOD OF MANUFACTURING A MOTOR STATOR ASSEMBLY
4090290 (OR) - METHOD OF MAKING AN ELECTRIC MOTOR WINDING INSULATING BARRIER

SUBCLASS 598 TOTAL 1 (OR) 1 (XR) 0 PCT OF TOTAL OR .7 PCT OF ALL (OR+XR) .2

4199861 (OR) - METHOD OF MAKING AN END PLAY CONTROL ASSEMBLY

SUBCLASS 609 TOTAL 2 (OR) 0 (XR) 2 PCT OF TOTAL OR 0.0 PCT OF ALL (OR+XR) .4

3518754 (XR) - METHOD OF MANUFACTURING A MOTOR STATOR ASSEMBLY
3821846 (XR) - METHOD OF MANUFACTURING A MOTOR STATOR ASSEMBLY

SUBCLASS 622 TOTAL 1 (OR) 1 (XR) 0 PCT OF TOTAL OR .7 PCT OF ALL (OR+XR) .2

3596352 (OR) - METHOD OF CALIBRATING BIMETALLIC ELEMENTS IN A THERMAL OVERLOAD SWITCH

SUBCLASS 732 TOTAL 3 (OR) 1 (XR) 2 PCT OF TOTAL OR .7 PCT OF ALL (OR+XR) .7

3689976 (XR) - COIL TRANSFER APPARATUS
3742595 (XR) - METHOD OF MANUFACTURING A SUBMERSIBLE MOTOR
3858296 (OR) - COIL PROCESSING APPARATUS

SIC PRODUCT FIELDS

PRODUCT FIELDS	SIC CATEGORY
Food and Kindred Products	20
Textile Mill Products	22
Chemicals and Allied Products	28
Chemicals, Except Drugs & Medicines	281, 282, 284-289
Basic Industrial Inorganic & Organic Chemistry	281, 286
Industrial Inorganic Chemistry	281
Industrial Organic Chemistry	286
Plastics Materials & Synthetic Resins	282
Agricultural Chemicals	287
All Other Chemicals	284, 285, 289
Soap, Detergents, and Cleaning Preparations, Perfumes, Cosmetics & Other Toilet Preparations	284
Paints, Varnishes, Lacquers, Enamels, and Allied Products	285
Miscellaneous Chemical Products	289
Drugs and Medicines	283
Petroleum & Natural Gas Extraction & Petroleum Refining	13, 29
Rubber & Miscellaneous Plastics Products	30
Stone, Clay, Glass and Concrete Products	32
Primary Metals	33, 3462, 3463
Primary Ferrous Products	331, 332, 3399, 3462
Primary & Secondary Non-Ferrous Metals	333-336, 339 (except 3399), 3463
Fabricated Metal Products	34 (except 3462, 3463, 348)

PRODUCT FIELDS	SIC CATEGORY
Machinery, Except Electrical	35
Engines & Turbines	351
Farm & Garden Machinery & Equipment	352
Construction, Mining & Material Handling Machinery & Equipment	353
Metal Working Machinery & Equipment	354
Office Computing & Accounting Machines	357
Other Machinery, Except Electrical	355, 356, 358, 359
Special Industry Machinery, Except Metal Working Machinery	355
General Industrial Machinery & Equipment	356
Refrigeration & Service Industry Machinery	358
Miscellaneous Machinery, Except Electrical	359
Electrical and Electronic Machinery, Equipment and Supplies	36, 3825
Electrical Equipment, Except Communication Equipment	361-364, 369, 3825
Electrical Transmission & Distribution Equipment	361, 3825
Electrical Industrial Apparatus	362
Other Electrical Machinery, Equipment & Supplies	363, 364, 369
Household Appliances	363
Electrical Lighting & Wiring Equipment	364
Miscellaneous Electrical Machinery, Equipment & Supplies	369

PRODUCT FIELDS	SIC CATEGORY
Communication Equipment & Electronic Components	365-367
Radio & Television Receiving Equipment, Except Communication Types	365
Electronic Components & Accessories & Communication Equipment	366-367
Transportation Equipment	37, 348
Motor Vehicles & Other Transportation	348, 371, 373-376, 379
Motor Vehicles & Motor Vehicles Equipment	371
Guided Missiles & Space Vehicles & Parts	376
Other Transportation Equipment	373-375, 379 (except 3795)
Ship & Boat Building & Repairing	373
Railroad Equipment	374
Motorcycles, Bicycles & Parts	375
Miscellaneous Transportation Equipment	379 (except 3795)
Ordnance Except Missiles	348, 3795
Aircraft & Parts	372
Professional & Scientific Instruments	38 (except 3825)

APPENDIX D

ACKNOWLEDGEMENTS

Patent and Trademark Office contributors to this publication are listed below. Special thanks are extended to Patent and Trademark Office professional and technical personnel whose continuing input to the Technology Assessment and Forecast program is indispensable.

OFFICE OF TECHNOLOGY ASSESSMENT AND FORECAST

STAFF:

William S. Lawson, Director
Terry S. D'Amico, Secretary

John F. Terapane, Ph.D., Senior Analyst
Jane S. Myers, Senior Analyst
Mary Ellen Mogee, Senior Analyst
Susan B. Rifkin, Senior Analyst
Gary R. Robinson, Analyst
James A. Peterson, Systems Analyst
Lisa A. Ferrari, Editorial Assistant
Ravonne P. Lee, Clerk Typist

PRINCIPAL CONTRIBUTORS FOR THIS REPORT:

Section I -	Jane S. Myers	Section III -	Nelson Moskowitz
Section II -	Jane S. Myers Susan B. Rifkin Carl W. Shepherd	Section IV -	Donald G. Kelly

CONSULTANTS

J. Russell Goudeau
Norman Morgenstern
Allen M. Ostrager
Galen Barefoot
Ray Penland

GRAPHICS

Sarah B. Fretty
LaDonna Kiesner
Renee Brown

EDITORIAL STAFF

Ronald V. Russell
Daniel A.J. Etzel
Sarah B. Fretty

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